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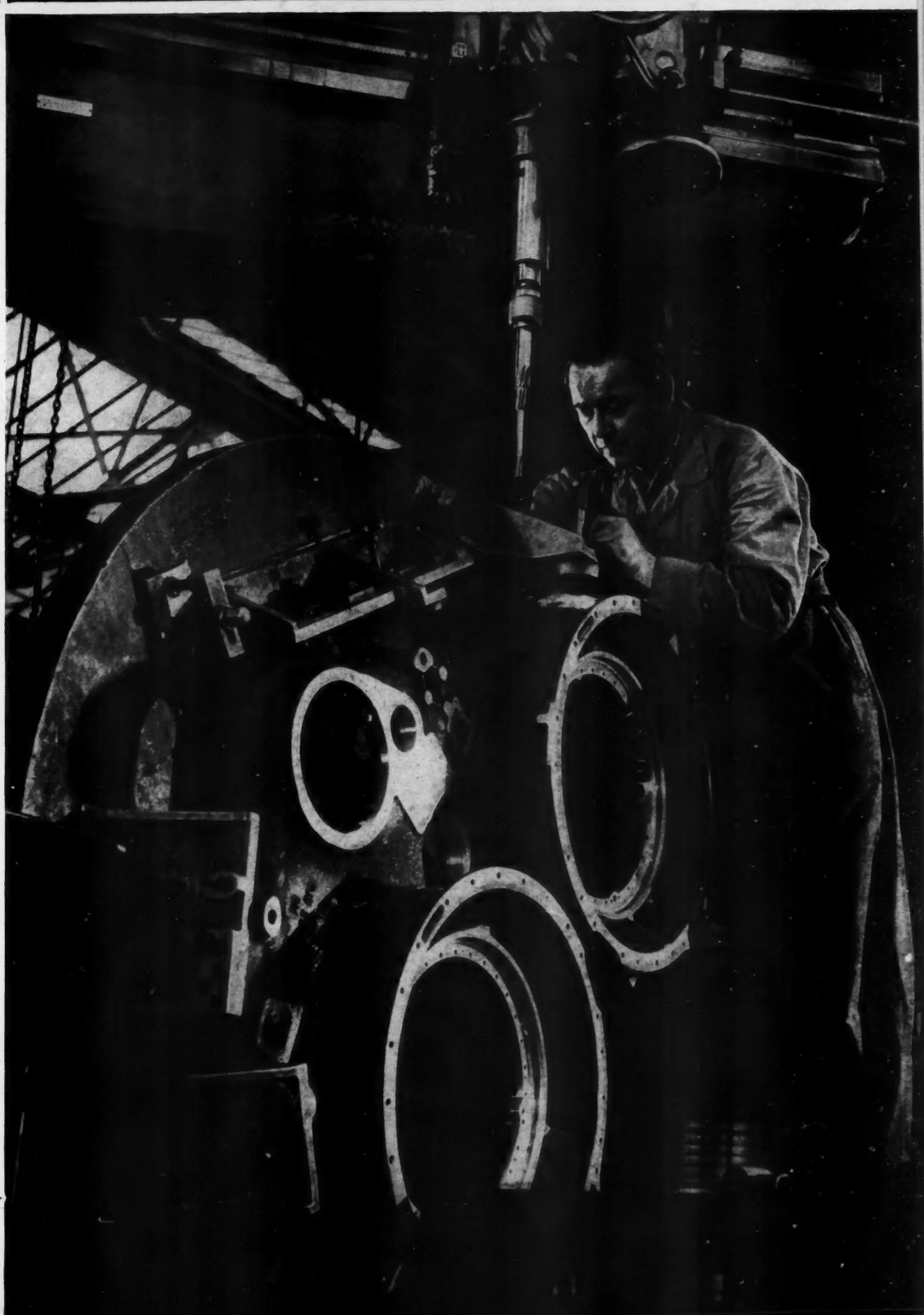

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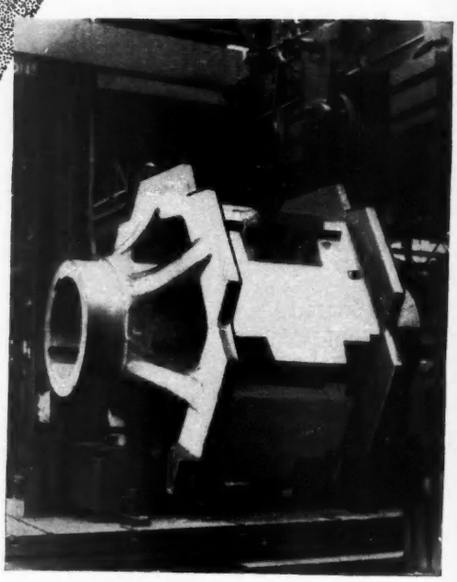

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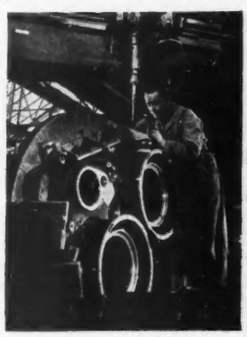

Cover Picture

Set-up for drilling operations on the front cover of a Double Mamba turboprop. (*Nurnberg photograph for* ENGINEERING)

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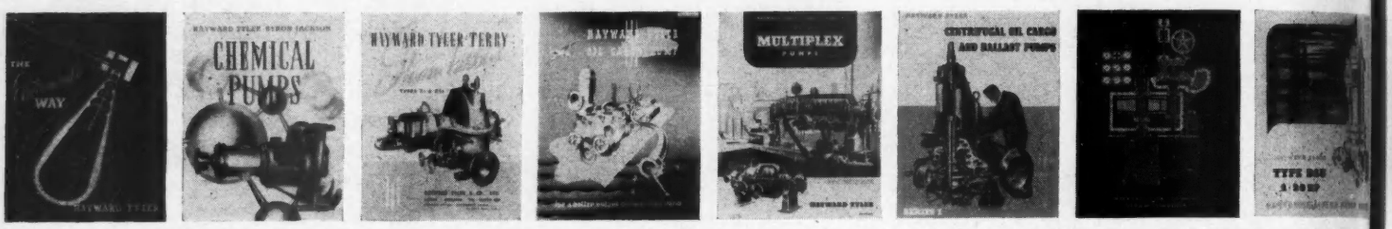

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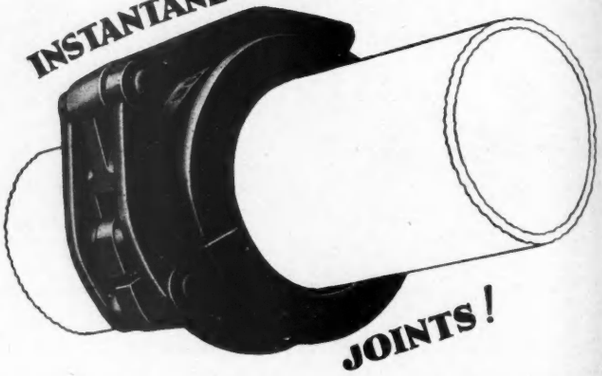

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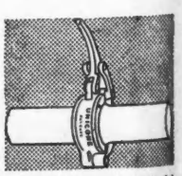
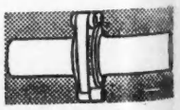


Pipe ends joined ready for locking



The joint completed

ENGINEERING Impact

of Rising Output and Greater Investment

THAT the overall industrial production of the United Kingdom should have remained more or less constant throughout last year, despite the effect of the credit restrictions on the consumer goods industries, coupled with the increasing rate of capital investment in industry, strongly suggests that a period of sharply rising output is likely.

The Central Statistical Office's latest figures show that from January, 1960, the index of industrial production (taking 1954 as 100) began at 119, rose to 121 by April, continued with only a slight fall in June at that level until October and in December was still at 120. Comparisons by industries are shown in the table.

This period includes the months when short time working was common among the car firms, and when some of the effects had reached their suppliers. It also, of course, covers the still continuing low level of activity among the makers of domestic appliances.

The high level of work on the capital goods side of the engineering industries, of the chemicals companies and in the aircraft and commercial vehicle industries are part of the still heavily committed side of the picture.

All the time that industrial output for the year has been keeping at an average of seven per cent above that of 1959, though by December it was only two per cent (120) above the level reached a year earlier (December, 1959—118) capital investment has been rising.

Private investment which had been rising one per cent per quarter in 1959 was increasing by four per cent in each of the first three-quarters of 1960. The Treasury, in its *Bulletin for Industry*, reports that so far as is known this continued through the fourth quarter and certainly the indications from the steel industry and others are that this is at least the case. This vigorous rate of improvement was predicted by the companies taking part in the Board of Trade's inquiry at the end of the year to be kept up this year.

Capital spending on buildings and building work is expected to be about 40 per cent greater than last year; investment in plant, machinery and vehicles a little below 30 per cent more. Leading the way in stepping up their productive capacities are the iron and steel industry, the car and heavy vehicles manufacturers and the paper makers and there are other sectors of industry for which larger spending is planned.

Looking back to 1959 the Treasury reports that, in real terms, the annual rate of fixed investment of that year was 50 per cent above the level of 1950. The proportion of the national product invested each year had gone up by 17½ per cent and the proportion of the gross national product going into investment—into increasing the potential size of the future national product—again rose sharply last year and shows every sign of doing so again this.

Gross Fixed Investment, Employment and Output in Selected Manufacturing Industries

	£ million Invested	1958 percentages of total in manufacturing		
	1954-58	Investment	Employment	Output
Food, drink and tobacco	403	10·6	9·5	12·1
Mineral oil refining	133	4·5	0·3	0·5
Other chemicals and allied industries	657	18·5	5·5	9·0
Iron and steel	454	14·1	5·8	7·2
Other metals	80	1·6	1·7	1·8
Engineering and electrical goods	643	15·8	21·9	21·9
Shipbuilding and marine engineering	62	2·0	3·6	2·9
Motor vehicles and cycles	236	5·5	5·1	5·6
Aircraft	104	2·1	3·5	3·6
Leather, leather goods, fur, clothing and footwear	54	1·1	7·2	4·2
Bricks, pottery, glass, etc.	140	3·4	3·9	3·8
Timber, furniture, etc.	53	1·2	3·3	2·8
Paper, printing and publishing	282	6·9	7·0	7·2
Rubber	63	1·6	1·4	1·3

Development Contracts for New Housing

It is one of the quainter characteristics of the building industry that while a new aircraft or a new locomotive means a new design incorporating improvement and advance, a new house means simply any house that has not yet been lived in, possibly differing only in detail from methods of construction that were old 30 years ago.

Methods of management, closely studied among the internationally known contractors and some of the not so large, are very much grandfather style elsewhere.

The £25 million announced by Mr. Henry Brooke, the Minister of Housing and Local Government, for approved housing associations to provide houses for rent is perhaps the element of the proposed new legislation most likely to produce significant advance in domestic building. The £3,000 house to be let for £4 a week has been mentioned as a possible target. Is there really anything in this?

The house of that price can be bought for a down payment very much less than the worth of many a family car. And the repayments each year on a £2,700 mortgage could be no further above such a rent than the cost each year of a weekly packet of cigarettes.

It may be what wants looking at is the figure £3,000. A series of questions need to be asked. Is it necessary, or the best value for money, to build with bricks? Is the traditional roof an expensive anachronism? Every penny increase on the hourly wage rate has a direct impact on the price of accommodation, so how much more room is there for research into productivity, into new materials, into management methods in domestic building?

There are professional positions heavily entrenched in the building occupations with wasteful delays and no lack of duplicated effort. Only a super-optimist could say that all were pulling in the same direction, or that their direction was better, cheaper accommodation.

The Government is proposing to put up £25 million in the hope that it will start a movement towards private provision of homes to let. That is essentially a question of cost, and on that it might be better to first of all have an official inquiry into the industry.

of the Franco-British Channel Power Link

The Channel power cable to be commissioned in September and brought into full use early next year, will mean more efficient use of the costly capital equipment of power generation in both France and Britain.

The two countries' periods of peak demand do not coincide, with the result that at breakfast time and factory starting up time in England power from France will be flowing at up to 160 MW, and when the French peak demand occurs power up to the same level will flow into the national grid of France.

Costs are expected to be about equal, the great advantage is that periodically surplus capacity in each country, which would otherwise have little to do but await the peak, will be functioning usefully.

Earlier this week the British Government was represented at a one-day meeting of the ministerial council of Western European Union, the sole body on which the United Kingdom alone sits with the six members of the European Common Market. It is a means through which Britain may draw closer, politically, to Europe. The Channel power link is a further reminder of the way in which British industries, whether for the larger markets, or as in this case for more efficient working and use of resources, are already building substantial bridges into the Europe of the Common Market.

Research and Work Study in Shipping Management?

Whatever the doubts entertained in the past on the competence of some critics of the British shipbuilding industry there can be no such qualification attached to observations coming from the chairman of the British and Commonwealth Shipping Company, Sir Nicholas Cayzer.

When he expresses his disturbance at the amount of research now being carried on in Britain compared with overseas shipbuilding industries he is speaking from the experience of a man whose job it is to know what overseas builders can do to keep his line in the forefront of shipping competition.

Since the building of the larger vessels is bound to be a relatively lengthy process, the necessity for research to be at least as advanced as among the competition is self-evident if ships and their engines are not to become obsolete as they take shape in the yards.

There are problems, too, for the men who use the ships the yards send them—the shipping managements. Sir Nicholas Cayzer, speaking to the United Kingdom Chamber of Shipping, urged the need for work study, for good public relations and for more research. Pre-entry training is the long established commonplace of so many industries that the solemn statement of this fact to the United Kingdom Chamber of Shipping seems in itself an indication of the progress yet to be made.

In Hamburg there is already a school which has become part of the normal way through which all dockers enter their occupation. Similar steps are on the way in Britain, and it is worth emphasising the importance to the manufacturing industries of speedier turn round in British ports.

A sudden contract where rapid delivery is essential, or more simply the maintenance of normally efficient schedules, can be badly thrown out by unpredictable, or predictably uncertain, passage of goods through the ports.

Among British shipowners a repeated cause for complaint is the plight of the coastal shipper. Relieved of part at last of its load of debt, the railways give to the coastal operators all the appearance of a subsidised competitor. Special rates by rail, and greater than usual care with prompt delivery, can play havoc with the coastal shippers trade.

For the past three years, it is now known, one coasting ship every nine days has been scrapped or sold abroad. This decline in a traditional British trade is seen by its operators as capable of being reversed, if the Government will intervene.

The loss to the shipyards producing replacement coasters is one result. Another is that there is a substantial world demand for coastal craft and a reliable home market for our own builders is a solid basis from which to offer competitive tenders to overseas operators.

and Trade Follows the Sputnik

All through March and April, unless something very unexpected occurs, the Russian automatic interplanetary station will be soaring along through space making its way towards Venus.

The satellite that was sent into orbit as the launching platform for the venture was massive—and reliable. Every time a fresh Soviet satellite rises from the earth, each time new ground, like the photography of the moon, is broken, the impression of the technical supremacy and the engineering capability of the Soviet nation is made that much clearer.

Among the new nations of Africa and Asia the practical advantage of giant spending to gain knowledge of remote spacial regions is almost as distant as the galaxies themselves. But it is clear that they too are impressed.

If Russia can handle space projects with this certainty, then who is to question her deliveries of steelworks, of machine tools, of all the varied engineering products that already figure in the intense export battles around the world.

The British shipping industry knows at first hand the ability of later starters to catch up in ability and competitiveness. The French have shown what can be done in aircraft and to some extent in the nuclear field.

Official British overtures for a European cooperation in a space research project received a mixed welcome but the Soviet station moving steadily towards Venus is an urgent reminder that staying out of this field may save a lot of money now—at the cost of much lost skill acquired in engineering solutions to a host of problems and of much valuable prestige.

User Comment on Collapsible Containers

Think of collapsible sea barges such as the Dracone; now consider the parallel development on land, the collapsible "pillow" tank. Here are a few outspoken comments on their future development.

IN CONDUCTING this survey on how industry is making use of collapsible containers, we had the opportunity of presenting the makers' point of view, the users', or both. The response to questions sent to nearly all the major users of such containers was so gratifying (in fact, 100 per cent) and the views put forward were so constructive, that it has been decided to present these as sent to us and to leave the article as a users' discussion. The replies of two firms are not included: Nitro-Liquor's use will be announced later, while Richard Thomas & Baldwins have little experience as yet.

In publishing several comments which point to apparent limitations and the need for design modifications we are not trying to detract from the value of the containers—in fact ENGINEERING has great faith in their future.

Some comments deserve highlighting since they point to a theme in users' views. Thus Penistone say they " are satisfied with the liquid-to-unit cost compared with other acid resisting containers " suitable for transporting vinegar. A company dealing with synthetic rubber latex is the only one, apparently, to have tried both pillow and rectangular containers tailored to fit a lorry when " it is more economical to use a rectangular shape than a pillow shape."

The coated fabrics seem to stand up to chemicals used by these users. For food, Penistone add " these tanks, in our experience, do not taint food products . . ." Yorkshire Electricity Board used one for temporary storage of transformer oil: " . . . it proved perfectly satisfactory." Leicester Lovell put phenolic resins in contact with the coated fabric and think they are " strong enough for our use." Attack on the rubber does not disturb the South West Suburban Water Company but in their words " . . . present coated fabrics do not appear to be strong enough to stand up to rough handling, as slight superficial damage has occurred."

Fittings need improvement and careful selection. " . . . Tank valves should be lighter in weight," say Leicester Lovell. The latex company mounted a 4 in valve externally on their lorry for their 3,200 imperial gallon container; the weight is thus taken off the container material. Some users would apparently like to see suppliers divine what threads will be used on the coupling, or certainly to have a selection available. Edinburgh Corporation Water Department say " . . . the 2½ in British Standard pipe thread is not a common size and we think it would be better if the outlet was adapted to suit a British Standard hydrant outlet."

With viscous liquids it appears best to have a pump handy. The latex company say that " . . . an unloading pump must be available as it is not possible to pressurise the container . . ." South West Suburban Water Company tried storing liquid aluminium sulphate and found that " the tank could be completely emptied by a small displacement pump . . ."

There is some doubt about stability of lorries with such loads. If the containers are full there is no chance of surging but " . . . when partially filled . . . side-by-side surges were considered dangerous . . ." say the latex company. Edinburgh Corporation Water Department also comment that " . . . if care is not taken in cornering, the rear end of the lorry is inclined to skid."

The big advantage of the collapsible containers, which is a main selling point of the makers, is that they will convert any lorry into an effective " tanker " for fluid or solid load.

Users quoted in this article have obtained their containers from one or other of the two firms shown below and we are grateful for cooperation from all companies concerned.

Dunlop Rubber Company Limited, Cambridge Street, Manchester.

Fireproof Tanks Limited, The Airport, Portsmouth.

Unloading a collapsible pillow tank full of phenolic resin.

Penistone Pure Malt Vinegar Company Limited

Cubley Brook Brewery,
Penistone, Yorkshire.

" Generally speaking the collapsible tanks have been entirely to our satisfaction, taking into account the limited period of service (8 months).

" The company has four 1,000 gallon containers in service, used at present for 5 per cent malt vinegar as static tanks in customers' premises supplied on rental and remaining the property of the company. These tanks, in our experience, do not taint food products and it is not necessary to vent when emptying. Maintenance of sterility is an important factor and this contributes to this end. Containers are at present served by conventional road tankers in stainless steel and further orders are initially limited to the 1,000 gallon size. Inquiries for 250 gallon units and upwards have been received.

" The existing design suits our requirements though in fact we attach a short length of flexible piping to the outlet to which valves are attached. This allows flexing of the tank during filling and emptying without straining the outlet. The choice of collapsible containers was dictated by their suitability under varying circumstances for supplying feed points throughout factories in the food trade. We have not in fact made use of the return empty factor but we are satisfied with the liquid/unit cost compared with other acid resisting containers of a suitable type.

" We have not found it necessary to take precautions against vandalism and the conditions of insurance and premiums included only fire at 2*s* 6*d* per cent.

" We consider the coated fabric to be strong enough for our use and see no signs of faults developing on the seams, but of course our service is less rigorous than other trades.

" Any company who wishes to extend their bulk trade services in chemical and food manufacturing would be well advised to explore the possibilities of the static service of these containers as well as the interchange of units."

Edinburgh Corporation Water Department

6 Cockburn Street, Edinburgh 1.

" We obtained a tank of 800 gallons capacity in July last. This was purchased as an experiment for use in carting water principally to the rural areas in the County of Midlothian when any shortage should occur. So far the tank has been used only on one occasion."

The Corporation say they think further development is needed in design and fixing arrangements. For instance, after the container is filled, one must exercise great care in fixing the container to the lorry. The lorry driver must be experienced because they have found that this load of 3½ tons is movable and fluctuating, and if care is not taken in cornering the rear end of the lorry is inclined to skid.

The inlet valve, say this Corporation, is wrongly placed. It is too high up on the container and does not lend itself to easy emptying. The screw on the inlet valve is 2½ in British Standard pipe thread. This pipe thread is not a common size and they think it would be better if the outlet was adapted to suit a British Standard hydrant outlet. Also, the air valve on the top of the container should be of a larger size.

South West Suburban Water Company

The Causeway, Staines, Middlesex.

" Our present 500 gallon rubber tank is used for emergency distribution of water to consumers and has been in operation about a dozen times in the last year. It is mounted on a lorry and is used either to fill consumers' receptacles or else it is connected to a range of taps.

" On experience to date, I should be confident in ordering another tank when the need arises. The present shape and method of harnessing of the tanks is satisfactory, but it would be advantageous to have them available with 2½ in V thread outlets to suit standard fire hydrants and hoses. The original outlet, 2 in BSP, I think, had to be modified to allow connection to hydrants with fire hoses.

" A collapsible container was eminently suitable for our uses since the tank occupies negligible storage space, and one man, in emergency, can harness and fill the tank. No special provision for insurance has been made. It does not appear that the present coated fabrics are strong enough to stand up to rough handling, as slight superficial damage has occurred.

" At one time the suitability of the tank for storing liquid aluminium sulphate was considered; it was found that the tank could be completely emptied by a small displacement pump coupled direct to the outlet valve."

Leicester, Lovell and Company Limited

North Baddesley, Southampton.

This company has obtained one 400 gallon

prototype tank which they have used for transporting Cascophen phenolic resins. So far they have made a test delivery of phenolic resin to Germany by a route over road and sea.

On present experience they say they will be ordering further containers. But they do think modifications should be made to the designs. For instance, tank valves should be lighter in weight; filling and emptying should be speeded up—possibly assisted by an arrangement of vents. Also, the harness should be "part and parcel" of the tank and not supplied separately as was the case with their prototype.

The main reason why they chose to test a collapsible container was to exploit the possibility of having free lorry space on the return journey. No special arrangements were made for insurance. The delivery of the Cascophen to Germany was fob. The general arrangement they have for insurance of their products in transit applied, and the company were not asked to disguise the tank.

The company think that present coated fabrics are strong enough for their use, but are keeping a look out for faults developing at the seams.

A Company Who Handle Synthetic Rubber Latex

"Our original purpose in purchasing a collapsible tank was for development work in connection with the economical transport of synthetic rubber latex. Latex with high solids content, such as we handle in these tanks, has the following typical properties: solids content, 63 per cent; viscosity, 1,500 cps (Brookfield); bound styrene, 24·0 per cent; pH, 10·0 to 10·5. The material is sometimes difficult to handle in that it will coagulate under adverse conditions and form solid rubber. It is tacky and may cause certain types of rubber with which it comes into contact to swell and deteriorate.

"We have one rubber-proofed nylon container of 3,200 gallons capacity (weight 5½ cwt) and also a 1,150 gallon tank (weight 1½ cwt) also of rubber-proofed nylon.

"The vehicles with which the tanks are associated are a fleet of 20 ton lorries. The lorries are tipping ones with a bed of 18 ft by 7 ft and, especially important, sides of 3 ft 10 in height. The duty of these lorries is to transport salt to our plant and carry solid rubber to our customers on the return journey. It was therefore decided to investigate the possibility of carrying rubber latex on these lorries.

"The larger tank is rectangular in shape and is sized so as to completely fill the lorry up to the top of the sides. The fittings are: a vent hole; a manhole; a 2 in nozzle (blanked off, provided for future use); and a 4 in inlet and outlet valve. As the tank completely fills the bed of the lorry the 4 in valve has been permanently mounted externally to the lorry and a neck of the tank material is taken through a hole in the bed of the lorry to the valve. This neck has to be attached to the valve whenever the tank is removed or replaced, but this is a relatively simple operation. The advantage of this system is that the relatively large weight of the valve is not supported by the tank material.

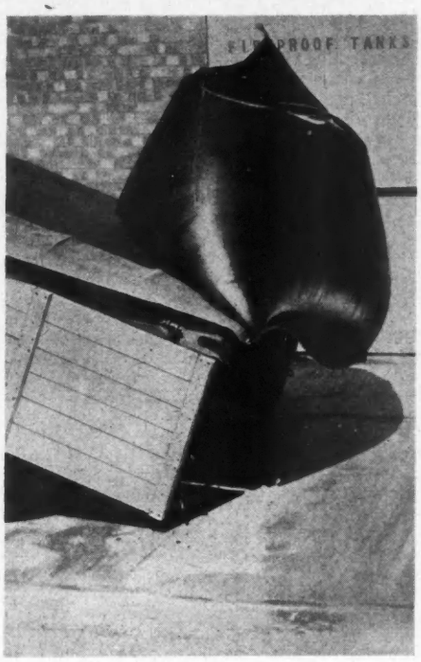
"The smaller tank is 'pillow shape' and the dimensions are 18 ft by 6 ft 10 in, the height being 2 ft 3 in when filled. Consequently the tank lies completely within the side walls of the lorry. The fittings are: a 2 in screwed connection on top of the tank; clamped ends; and a 2 in inlet and outlet valve which is entirely supported by the material of the tank.

"We consider that clamped ends are excellent from the point of view of cleaning.

"The initial tests carried out on the tanks are of an obvious nature. They consisted of filling them with water, carrying out road tests of the vehicle in order to observe the effect of cornering, braking, accelerating, etc., and then emptying and packing the tanks. During these tests it was found essential to completely fill the containers as otherwise the presence of air in the tanks is conducive to severe surges of the liquid. It is for this reason that use of our large container has been suspended recently (awaiting modifications to make a slight reduction in size) because the container is slightly heavier than the tolerable load for the lorry when completely full, and it was thus necessary for the container to be used only partially filled. Though the front-to-rear surges were tolerable, the side-to-side surges were considered dangerous and the tank was withdrawn—not until it had completed eight trips of 250 miles, however. The smaller container has been in regular use on a weekly basis for the past five months and to date has completed approximately 3,500 miles when full.

"Apart from the initial tests we are still observing the behaviour of the tanks with regard to wear and tear, sticking of the fabric and necessity for cleaning. The results are encouraging so far but we do not intend to consider purchase of any more tanks until the present trial tanks have been in service for at least one year.

"We have not found it necessary as yet to



It is not recommended that users should unload their containers by tipping or rolling them on the ground, but at least they are strong enough to withstand the stresses should this ever happen.

open either tank for cleaning—this is probably due to the fact that we insist on the tanks being washed out before being rolled up.

"Owing to the peculiar nature of our material, we are limited in our choice of valves. We have to use either a plug or a diaphragm valve. Furthermore we cannot allow any copper-bearing metals to come in contact with the rubber latex, and the use of aluminium valves would be intolerable for periods when the lorry is carrying its normal cargo of salt.

"From our point of view, with lorries with high sides, it is more economical to use a rectangular shape than a pillow shape. The drawback of the rectangular shape is that naturally it is more difficult to fold and stow away. However, it is still a job that is handled comfortably by the driver and an assistant.

"We are not too concerned with fixing to the lorry as we merely rope across the tops of the sides and this contains the tank within the lorry.

"With regard to the smaller container we have been able to benefit by the fact that it is an extremely simple operation to roll up the container and remove it, and then stow it on top of the salt when the lorry is loaded for its return journey. With the larger tank it is more convenient to roll it up, lash it in position, cover it with a tarpaulin and then submerge it with salt. No trouble has been experienced with insuring either the containers or the goods carried therein.

"The present fabrics would seem to be strong enough for their purpose inasmuch that no failures have been experienced so far. The seams are still sound.

"We would hesitate to suggest any specific firm as possible users of flexible containers. In general, however, they must receive favourable consideration from any manufacturer who runs two liquid cargoes in opposite directions when the two liquids will contaminate each other.

"As regards disadvantages of this type of container there are a few points we would like to mention:

In loading it is essential that all the air be removed.

Unloading is, to our mind, the major disadvantage of the containers. It is necessary that the consignee have an unloading pump available, as it is not possible to pressurise the container with air in order to unload the contents. In addition we find it an advantage to be able to tip the lorry in order to facilitate unloading. This is almost essential in the case of the large rectangular tank but so important for the small tank as this tank can be rolled up as it is being emptied.

Surging of the contents: the absence of baffles in the tanks is conducive to surging. This problem becomes more serious as the size of the tank is increased. Although the problem can almost be overcome by ensuring that the tanks are completely full this is not always possible. From our point of view we feel that the solution to the problem, taking into account the economic aspect, would be to use two of the smaller tanks of approximately 1,250 imperial gallons capacity, carrying them one on top of the other. (This is not recommended at present.) It would have the advantage of baffling the contents, utilising the complete capacity of our lorries while still retaining easy handling of the empty tanks, and allowing more flexibility in that it would be possible to carry two grades of latex on one lorry."

Yorkshire Electricity Board

No. 4 (Leeds) Sub-Area,
Bramhope, Leeds.

"Our experience to date with the 1,000 gallon unit in our possession is rather limited. This particular one was obtained as a receptacle for the temporary storage of oil removed from electrical equipment during maintenance and so far it has been used only once. On this occasion it proved perfectly satisfactory, no difficulty being experienced either in filling or draining, and the whole process was quite clean. The container was easily rolled and repacked in its box after use and I am quite satisfied with the principle. It is not intended to use this container for the actual transport of oil as a road tanker is kept for this purpose."

South Wales Electricity Board

Swansea and West Central Area,
29 Ystrad Road, Swansea, Glamorgan.

"Although we are in possession of such containers, we have not had an opportunity of making use of them. Our purpose in acquiring the tanks (which are 500 gallon capacity) is to temporarily store large quantities of transformer oil on substation site, should it be necessary, due to a transformer breakdown, to remove the oil from the transformer. This is sometimes needed to examine and effect a repair, or to allow removal of the transformer from site for repair at a manufacturer's works.

"Previously it has been our practice, when called upon to handle oil in quantity, to make use of RAF Bowsers which had to be towed to site by a heavy lorry suitably equipped with the necessary pneumatic braking system. There does seem to us definite advantage in making use of these collapsible containers for the purpose we have in mind."

Plain Words

By Capricorn

How often I have caught myself resenting the riches of the rich. Are they so much more deserving than the rest of us? Their parties are a scandal; their clothes and sports absurd—or so it seems when I myself am feeling poor. But lately I have noticed that those very symbols which I once so much despised are popping up at home. There's a new car in the garage, a mobile in the hall, and sherry (very dry) in the cabinet. I have even started wearing a different kind of hat, and found myself complaining about the iniquity of taxes. I'm beginning to discover that the rich are not so rich as I supposed.

I'm not pretending that a higher salary can mean a lower income—though you might be led to think so by letters in the press. And until you're very rich indeed, a rise can still be detected in your bank account. But if you're making any progress, you will very quickly find that the asymptotic ceiling on your income isn't high—though fringe effects can make a lot of difference.

For example, a company just starting up in business may be trying to recruit some first-class men. It is unlikely to have much capital to spare and no knowledge of the loopholes in taxation. But if it cannot offer houses, cars, welfare services, free meals, free haircuts, free baths, free beer, the lot, it will have great difficulty in competing successfully for staff.

A friend of mine who has a modest position with one of the biggest and most welfare-conscious companies in Britain, calculated what these untaxed benefits were worth. He told me that they were equivalent to several thousand pounds and placed him in a bracket with the Thompsons and the Kings—or very nearly.

But there are subtler more insidious equalising forces than taxation. Add to taxation, for example, the hidden levy of the means test, and you may find that the rewards earned by your industry and enterprise have disappeared completely. Make sure your sons and daughters do not prove too talented, or in allowing them to take their rightful places at a university, you may impoverish yourself.

Of course the rich themselves are very much in favour of equality—at least the evidence appears to point in that direction. A wealthy man, for instance, may send his children to a private school which provides an education very little better than the state-school education which he pays for indirectly in addition. His car will be large, custom built, lined perhaps with leopard skins, and, though only marginally more useful than the popular models, will cost many times as much. He will also take his alcohol in brandy, when beer would serve the purpose just as well. Thus by paying more for substantially the same commodities the wealthy cut their income down to size.

I applaud their public spirit.

Letters to the Editor

Library Minded Engineers and Scientists

SIR, Sometimes I have wondered how to distinguish between an engineer and a scientist. Now Mr. Frank H. Smith seems to have found the answer. One reads; the other doesn't (ENGNG., 17 Feb. '61, p. 244).

What is so meritorious or noble about this penchant for reading? Perhaps the engineer's neglect of it is based on sound conclusions. Perhaps he has observed, deduced, assessed and decided not to waste his time. There was a time when the monks did all the reading, but their period remained "the Dark Ages." Along came the unread engineers, for their subject had no reading matter. Papin, Savery, Newcomen, Watt. Reasoners, not readers. What an impact they made! What a debt we owe them now!

It seems churlish of a Smith to admonish as recalcitrant, the engineer, just because times have separated him from his anvil—yes both. But I did expect him to call attention to the studies made by the Central Office of Information, the Department of Scientific and Industrial Research and the European Productivity Agency; inquiring what they read, where they read it, whether they read and why they read or do not read.

Yours faithfully,
W. D. ARNOT.

Nuneaton, Warwicks.
22 February, 1961.

Damping a Rotating Shaft

SIR, May I refer to the letter on "Bent Shafts," by Mr. Joseph Morris (ENGNG., 23 Dec. '60, p. 848), in which he comments on my article entitled "Unbalanced and Initially Bent Shafts" (25 Nov. '60, p. 735)?

Consider a light flexible shaft which is simply supported at its ends and which carries an offset particle (or disc) of mass m at mid-span. This is the system dealt with in my previous article. The purpose of this note is to show how vibration of the shaft (brought about by rotation) may be described in a number of ways according to the choice of coordinates and the assumptions made as to the damping. There appears to be some misunderstanding concerning this of a very basic nature.

In the accompanying figure, O represents the intersection of the line of the bearings with the transverse plane of the shaft at mid-span. C, the "elastic centre," is the intersection of the deformed elastic axis of the shaft with that plane. The point P is fixed in the disc and is the "damping centre" through which the damping forces will be supposed always to act; the significance of this will become apparent later and there is no real point in distinguishing between internal and external damping in defining P. M is the instantaneous position of the particle in the transverse plane at mid-span. OUV are axes which rotate about O with the angular speed Ω of the shaft.

The equations of motion of the particle in the fixed directions with which OU and OV coincide nstantaneously are, respectively,

$$\left.\begin{aligned} m\,[\ddot{v} - (v + a)\Omega^2 - 2\Omega\dot{v}'] = \\ -k(v - v_o) - b_i\dot{v} - b_e[\dot{v} - (v' + b')\Omega] \\ m\,[\ddot{v}' - (v' + a')\Omega^2 + 2\Omega\dot{v}] = \\ -k(v' - v_o') - b_i\dot{v}' - b_e[\dot{v}' + (v + b)\Omega] \end{aligned}\right\} \quad (1)$$

Here k is the shaft stiffness, b_e and b_i are coefficients of external and internal damping respectively and v_o, v_o' are the components of initial bend in the directions OU, OV; the remaining symbols are defined in the figure. Let

$$\omega_1^2 = \frac{k}{m}\ ; \quad \mu = \frac{b_e}{2m\omega_1}\ ; \quad \nu = \frac{b_i}{2m\omega_1} \quad (2)$$

and

$$\eta = v + iv'; \quad \bar{a} = a + ia'; \quad \bar{b} = b + ib'; \quad \epsilon = v_o + iv_o' \quad (3)$$

where $i = \sqrt{(-1)}$. With this notation, equations (1) reduce to the single equation:

$$\ddot{\eta} + 2\,[(\mu + \nu)\,\omega_1 + i\,\Omega]\,\dot{\eta} + [(\omega_1^2 - \Omega^2) + 2\,i\,\mu\,\omega_1\,\Omega]\,\eta = \Omega^2\bar{a} + \omega_1^2\epsilon - 2\,i\,\mu\,\omega_1\,\Omega\bar{b} \quad (4)$$

in the complex variable $\eta(t)$. The complete solution of this equation contains a complementary function and a particular integral; the former has been examined in detail previously[1] and the latter will now be investigated. It is

$$\eta = \frac{\Omega^2\bar{a} + \omega_1^2\epsilon - 2\,i\,\mu\,\omega_1\,\Omega\,b}{\omega_1^2 - \Omega^2 + 2\,i\,\mu\,\omega_1\,\Omega} \quad . \quad (5)$$

and certain special cases may be identified—the possibility of which has been indicated before.[2] Some of them will now be outlined.

Case 1.—It has seemed to me that, in developing an analysis, one should use η as the measure of the shaft distortion (rather than, say, $\eta + \bar{a}$). This seems particularly justified if balancing masses are employed. If this is accepted, then it seems hard to justify any value of $\bar{b}$ other than $\bar{b} = 0$; for the particular integral (5) only involves external damping and this is dictated by the distortion of the shaft. This standpoint has been adopted in references 1 and 2, and its validity can be decided in one way only—by test. After a lengthy series of experiments (which are in the process of being written up) conducted by A. G. Parkinson and K. L. Jackson, it seems clear that the assumptions are largely justified.

Case 2.—In his original (and vitally important) work, H. H. Jeffcott[3] also discussed the position of C so that the distortion was η. He also assumed, in effect, that $\bar{b} = 0$ so that the damping acts at C. Finally, he made no allowance for initial bend so that $\epsilon = 0$. Under these conditions, the result (5) gives

$$\eta = \frac{\Omega^2\bar{a}}{\omega_1^2 - \Omega^2 + 2\,i\,\mu\,\omega_1\,\Omega} \quad . \quad (6)$$

which is the special form of case 1 which arises where $\epsilon = 0$.

Case 3. In his letter to you, Sir, above referred to, Mr. Joseph Morris points out another possibility. His assumption seems to be that $\epsilon = 0$ and $\bar{b} = \bar{a} \neq 0$ so that the position of C becomes

$$\eta = \frac{(\Omega^2 - 2\,i\,\mu\,\omega_1\,\Omega)\,\bar{a}}{\omega_1^2 - \Omega^2 + 2\,i\,\mu\,\omega_1\,\Omega} \quad . \quad (7)$$

But now the suggestion appears to be that the distortion should be measured, for some reason, by the position of M rather than of C so that (7) gives

$$\text{distortion} = \eta + \bar{a} = \frac{\omega_1^2\bar{a}}{\omega_1^2 - \Omega^2 + 2\,i\,\mu\,\omega_1\,\Omega} \quad . \quad . \quad . \quad (8)$$

The result is sound enough, mathematically.

If I follow Mr. Morris's letter correctly (and it does seem a little confused) it contains what is in effect the following statement. Equation (8) is "precisely the same" as the special case of equation (5) which arises when $\bar{a} = 0 = \bar{b}$ and $\epsilon \neq 0$. It also appears that this is taken to

mean that there is no valid distinction to be drawn between the two results. Both of these assertions are clearly false.

By being consistent, one can in fact reach an interesting result in the manner of case 3. Continuing to measure the distortion by $\eta + \bar{a}$, let $\bar{b} = \bar{a}$ and suppose $\epsilon \neq 0$. Then (5) gives

$$\text{distortion} = \eta + \bar{a} = \frac{\omega_1^2 (\epsilon + \bar{a})}{\omega_1^2 - \Omega^2 + 2 i \mu \omega_1 \Omega} \quad . \quad . \quad . \quad (9)$$

and the implication is that, on making $\bar{a} = -\epsilon$ by the attachment of balancing masses, one can nullify the vibration due to initial bend exactly. Laboratory tests do not appear to confirm this, however, as might be expected on physical grounds.

Case 4. Other possibilities do exist and they may easily be investigated mathematically. There appears to be little point in taking them up in detail here since they seem rather academic. For instance, it may be assumed that $\bar{a} = 0 = \epsilon$ but $\bar{b} \neq o$ so that a forced whirl is caused by damping only, according to the equation

$$\eta = \frac{-2 i \mu \omega_1 \Omega \bar{b}}{\omega_1^2 - \Omega^2 + 2 i \mu \omega_1 \Omega} \quad . \quad (10)$$

Is this anything to do with oil whirl? Next the possibility of balancing or, say, the differences between hysteretic and viscous damping may be examined. And so one may go on.

It is of the very nature of engineering analysis that one must adopt assumptions. Those relating to damping are notoriously difficult to make with accuracy and there is only one way to check them—that is by experiment. In this particular matter, the only experimental evidence available to me supports case 1 above.

To assert, as Mr. Joseph Morris does, that, because someone else does not use the same assumptions as oneself (even when one's use of them is consistent) he is "confused" and that his results are "anomalous" not only seems a little offensive, but also it appears to show a lack of understanding of the nature of engineering analysis.

Yours faithfully,
R. E. D. BISHOP.

Department of Mechanical Engineering,
University College London, WC1.
2 February, 1961.

References

[1] Bishop, R. E. D. "The Vibration of Rotating Shafts" (Instn. Mech. Engrs., London). *J. Mech. Eng. Sc.*, vol. 1, 1959, p. 50.

[2] Bishop, R. E. D., and Gladwell, G. M. L. "The Vibration and Balancing of an Unbalanced Flexible Rotor" (Instn. Mech. Engrs., London). *J. Mech. Eng. Sc.*, vol. 1, 1959, p. 66.

[3] Jeffcott, H. H. "The Lateral Vibration of Loaded Shafts in the Neighbourhood of a Whirling Speed; the Effect of Want of Balance." *Phil. Mag.* (Series 6), vol. 37, 1919, p. 304.

Honeycomb Cores as Structural Materials

SIR, Our attention has been drawn to a letter on metal honeycomb core by Mr. E. J. Catchpole of CIBA (A.R.L.) Limited (ENGNG., 3 Feb. '61, p. 180).

While we agree that metal honeycomb is well established as a structural material in the aircraft industry, we feel that to convey the complete picture to your readers, due credit must be given to the other forms of honeycomb widely employed in this field. These include the resinated kraft paper, furane impregnated paper and glass-fibre cloth honeycombs which have been successfully applied for purposes where metallic cores were unsuitable.

This is particularly true where electrical transparency must be achieved, economies effected, or where special characteristics are required, as in the construction of shock absorbing pads for aerial supply deliveries. Dufaylite honeycombs have in fact given satisfactory service in over 30 well known types of civil and military aircraft.

We are, at present, the only company manufacturing a complete range of structural honeycombs and having licensee companies in most principal countries. Our experience in wide fields of application over a period of many years is available to customers on all matters of design, manipulation and laminating technique.

Yours faithfully,
J. H. GORELL,
Managing Director.

Dufaylite Developments Limited,
Boreham Wood, Herts.
21 February, 1961.

Mixing Gases

SIR, Dr. E. A. Bruges's answer (ENGNG., 10 Feb. '61, p. 213) to my letter (23 Dec. '60, p. 848) is as ambiguous as I expected it to be. He says that my question is pointless and that the proof of the usual expression of entropy increase

$$\Delta S = \frac{R}{J}\left(n_1 \ln \frac{p}{p_1} + n_2 \ln \frac{p}{p_2}\right)$$

can be found in any textbook, including *Theory of Heat*, by Max Planck.

But Planck proves this expression by means of permeable membranes, and I asked precisely whether, in Dr. Bruges's opinion, it would be possible to reach the same expression without making use of them. Moreover, Planck, himself, acknowledges that the properties attributed to the permeable membranes are not obvious and are accepted only owing to their simplicity and to the fact that they had been verified in some rare cases (Planck, as many other authors, gives only one example, that of incandescent platinum sheet which is permeable to hydrogen, but not to air). Thus Dr. Bruges is right in saying that he stands in good company; but, respectable as this company is, its theory of mixing gases is erected on a very fragile foundation.

As a matter of fact, this theory does not offer only one flaw, but two of them. Here is the first one. It is well known that the unit of entropy (expressed per unit mass) is identical with the unit of specific heat; and, indeed, entropy is a specific energy. But, in applied thermodynamics, we encounter only entropy differences; so entropy is a measure of the energy which is necessary for bringing a body from a given state to another one which is considered as the "initial state."

More precisely, entropy is the specific energy (per unit mass and unit of absolute temperature T_0 corresponding to the initial state) which has to be spent, after an adiabatic and reversible process ending at temperature T_0, in order to bring the body to the initial state; this energy is then $Q = T_0 \Delta S$, ΔS being the entropy difference between the given and the initial states. The main thing is to define correctly the "initial" state. I have some experience of a closed cycle air turbine, and I can attest that in no place in the circuit is air decomposed into its constituents. Then, if I try to calculate the available energy of the hot air at the inlet to the turbine, I can choose for "initial" state the state of air at the inlet to the compressor, or the state of air outside the set, and the result of my calculation will, of course, be different in these two cases. But it would be preposterous to consider as "initial" the state of decomposition of air into nitrogen and oxygen, and to take into account the energy which would be necessary to reach it.

We can replace in imagination the air turbine by two other turbines, one of them working with nitrogen and the other with oxygen, each of these gases having the same mass flow, the same temperatures and the same pressure ratio as in the air turbine; the total output, as the total heat consumption, of the two pure gas turbines will then be the same as in the case of the air turbine and, consequently, the mixing of the gases before their introduction into the circuit does not change their total available energy or their entropy.

It is immaterial to consider the pure gases under the total or the partial pressures they have in the air turbine; the only thing which matters is to choose the total *or* the partial pressure once for all and so secure for each gas the same pressure ratio in the cycle. The conventional theory is wrong, as it artificially considers as "initial" the state of decomposition of the mixture and thus chooses for each constituent its partial pressure at the beginning of expansion, and its total pressure at the beginning of compression.

It is only in cases when we are interested, not in production of energy, but in separation of the constituents of a gaseous mixture, that we must consider as "initial" (in actual fact, as final) state that of complete decomposition of the mixture; and it is here that appears the second flaw in the conventional theory. The decomposition of a mixture is *not* made by means of permeable membranes, and the corresponding value of ΔS is *not* that which is given by the expression above; if it were so, the separation of uranium isotopes would not be so expensive as it is, as the necessary expenditure of energy would then be theoretically about 50,000,000 times smaller than its actual value.

Actually the separation of mixed gases is made by means of centrifugation, or fractionate distillation, etc.; and, in each case, the expenditure of energy depends on the nature of the constituents, whereas the above expression of ΔS does not take their nature into account. Thus the conventional theory of mixing gases is inconsistent with the facts; in this second case there *is* an entropy change, but its true value can be found only by means of the information theory.

But Dr. Bruges considers only the first sight of the question and he believes that, even if a demonstrator shows us that the available energy has not decreased due to mixing, we cannot infer that there is no increase in entropy. This statement is inconsistent, as the variation of available energy is given by $T_0 \Delta S$. Dr. Bruges adds that if we do not see the demonstrator, "The Universe sees him and the usual toll in the form of entropy increase is exacted." I can tell nothing about this assertion, having only human eyes and a human understanding.

The Universe's testimony might be most convincing, were we able to hear it, instead of only guessing it. But, after all, heat machines and their theory have been developed by human beings and for their own use, not for that of the Universe.

Yours faithfully,
P. CHAMBADAL.

Electricité de France,
Paris, 16e.
21 February, 1961.

University Action on Factors of Safety?

SIR, I have only just seen Mr. N. L. Svensson's article entitled "Factor of Safety Based on Probability" (ENGNG., 27 Jan. '61, p. 154) and it is without surprise that I note that even he seems never to have heard of my own paper ("Statistical Methods and Factors of Safety: An Argument for the Revision of Existing Standards," *J. Inst. Elec. Engrs.*, vol. 87, No. 523, July, 1940) in which I came to not very dissimilar conclusions.

As far as I am aware, that paper has now attained its majority without making the slightest impact upon rule-of-thumb methods that were thought up by the pioneers before university education was thought part of the training of an engineer. We should not blame the rule-of-thumb practitioners for failing to appreciate how inefficient they can be for at least part of the time; but what, if anything, are the universities doing about it?

Yours faithfully,
W. T. O'DEA.

West Horsley, Surrey.
25 February, 1961.

Exhibitions and Conferences

Ergonomics, First International Congress on.—Sun., 20 Aug., to Wed., 23 Aug., in Stockholm. Theme: "The Adjustment of Work and Working Environment to Man." Organised by the International Ergonomics Association. Inquiries should be addressed to Professor Sven Forssman, Svenska Arbetsgivareföreningen, Post Box 16120, Stockholm 16, Sweden. United Kingdom representative on the Association's provisional committee: Ronald G. Stansfield, 213 Fairview Road, Stevenage, Herts.

Wellington International Trade Fair.—Tues., 22 Aug., to Sat., 9 Sept. Organised by the Wellington Show Association, Wellington, New Zealand.

Gas Dynamics Symposium, Fourth Biennial.—Wed., 23 Aug., to Fri., 25 Aug., at the Northwestern University, Evanston, Illinois, USA. Organised jointly by the University and the American Rocket Society. Apply to the Gas Dynamics Symposium, Mechanical Engineering Department, Northwestern University, Evanston, Illinois, USA.

Radioisotopes in the Biological Sciences, Conference.—Wed., 23 Aug., to Fri., 1 Sept.; but may be changed to dates in December. Apply to the International Atomic Energy Agency, Kaerntnerring, Vienna 1, Austria.

Technics and Technical Achievements, Fifth International Fair of.—Wed., 23 Aug., to Sat., 2 Sept., in Belgrade. Apply to Beogradski Sajam, 14 Bulevar Vojode Misica, Belgrade.

Textiles: Men's Fashion Week.—Sat., 26 Aug., to Mon., 28 Aug., in Cologne. United Kingdom inquiries should be sent to Mr. Neven du Mont, 123 Pall Mall, London, SW1. Tel. WHItehall 8211.

International Civil Aviation Organisation (ICAO): Diplomatic Conference on the Unification of Certain Rules Relating to International Carriage by Air Performed by a Person Other than the Contracting Carrier.—Tues., 29 Aug., in Montreal, Canada (tentative). Offices of ICAO: Montreal, Canada.

British Association Meeting.—Wed., 30 Aug., to Wed., 6 Sept., at Norwich. Apply to the secretary, British Association for the Advancement of Science, 18 Adam Street, Adelphi, London, WC2. Tel. TRAfalgar 5733.

St. Erik's Fair, 19th.—Wed., 30 Aug., to Sun., 10 Sept., in Stockholm. Agents: Trade Fairs and Promotions Ltd., Drury House, Russell Street, London, WC2. Tel. TEMple Bar 3422.

Handicrafts and Do-It-Yourself Exhibition, Ninth International.—Thurs., 31 Aug., to Sat., 16 Sept., in the Empire Hall, Olympia, London, W14. Exhibition offices: Link House, Store Street, London, WC1. Tel. MUSeum 9792.

Nuclear Development: Impact on Electricity Supply and on Instrument Techniques, Convention.—In September, in London. Organised by the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. Tel. COVent Garden 1871.

Meetings and Papers

British Institution of Radio Engineers

LONDON
"Electronic Instrumentation for Cardiac Surgery": Symposium. Medical Electronics Group. Post Graduate Medical School, University of London, Du Cane Road, Hammersmith, W12. Mon., 27 Mar., 2.30 p.m. (Registration is necessary.)
"Electronic Instrumentation for Nuclear Power Stations": a symposium of six papers. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 29 Mar., 3 p.m.

Building Centre

LONDON
"Rolled Asphalt": films on Continental asphalt roads, exhibited by Previté and Co., Ltd. Wed., 29 Mar., 12.45 p.m.

Combustion Engineering Association

LONDON
"New Designs and Techniques in the Construction of Water-Tube Boilers," by Dr. Ing. Heinrich Vorkauf. Criterion Restaurant, Piccadilly Circus, SW1. Wed., 29 Mar., 2.15 p.m.

Illuminating Engineering Society

BIRMINGHAM
"Hospital and Operating Theatre Lighting," by S. Hubbold. Birmingham Centre. Regent House, St. Phillip's Place, Colmore Row, Birmingham. Mon., 27 Mar., 6 p.m.
LEICESTER
"An Electrical Engineer in Local Government Service," by D. L. Richards and A. E. Griffiths. Leicester Centre. Demonstration Theatre, East Midlands Electricity Board, Charles Street. Leicester. Mon., 27 Mar., 6.15 p.m.

Institute of Marine Engineers

NEWCASTLE UPON TYNE
"Materials for Advanced Steam Conditions and Their Influence on the Operation of Marine Steam Turbines and Boilers," by Commander H. E. C. Hims and S. H. Frederick. North East Coast Section. Stephenson Building, King's College, Newcastle upon Tyne 2. Thurs., 30 Mar., 6.15 p.m.

Institute of Metals

SWANSEA
Annual General Meeting and Chairman's Address. South Wales Local Section. Metallurgy Department, University College, Singleton Park, Swansea. Tues., 21 Mar., 6.30 p.m.*

Institute of Road Transport Engineers

PRESTON
"Road Safety": Discussion. Northern Centre. Victoria and Station, Preston. Thurs., 30 Mar., 7.30 p.m.

Institution of Chemical Engineers

LONDON
"A Systematic Classification of Chemical Processes and Equipment," by K. Fischbeck. Joint meeting with the Chemical Engineering Group. At the Society of Chemical Industry, 14 Belgrave Square, SW1. Tues., 11 April, 6 p.m.

Institution of Civil Engineers

LONDON
"Traffic Engineering Problems on Motorways Between Cities and Airports in France": introduced by H. Grimond. Traffic Engineering Study Group. Thurs., 23 Mar., 5.30 p.m.*

Institution of Electrical Engineers

LONDON
"Engineering Aspects of Plasma Physics," by R. Carruthers and D. L. Smart. Joint Meeting of the Electronics and Supply Sections. Wed., 22 Mar., 5.30 p.m.*
"Technical and Economic Aspects of the Supply of Reactive Power in England and Wales," by W. Casson and H. J. Sheppard. Thurs., 6 April, 5.30 p.m.*
BIRMINGHAM
"Integration of Industrial and Academic Training": Discussion, to be introduced by E. C. Merrick. South Midland Education Discussion Circle. College of Technology, Gosta Green, Birmingham. Thurs., 23 Mar., 6 p.m.
BOURNEMOUTH
"Radiocommunication in the Power Industry," by E. H. Cox and R. E. Martin. Southern Centre. Grand Hotel, Bournemouth. Wed., 22 Mar., 6.30 p.m.
EDINBURGH
"Potentialities of Artificial Earth Satellites for Radiocommunication," by W. J. Bray. South East Scotland Subcentre. Carlton Hotel, Edinburgh. Tues., 28 Mar., 7 p.m.
NEWCASTLE UPON TYNE
"Technical and Economic Aspects of the Supply of Reactive Power in England and Wales," by W. Casson and H. J. Sheppard. North Eastern Centre. Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 27 Mar., 6.30 p.m.
SHEFFIELD
"Technical and Economic Aspects of the Supply of Reactive Power in England and Wales," by W. Casson and H. J. Sheppard. Sheffield Subcentre. Grand Hotel, Sheffield. Wed., 29 Mar., 6.30 p.m.

Institution of Engineering Inspection

GLASGOW
"Flash Evaporator Plant," by Dr. R. S. Silver. West of Scotland Branch. St. Enoch Hotel, Glasgow. Wed., 29 Mar., 7.30 p.m.

Institution of Heating and Ventilating Engineers

GLASGOW
"Recent Developments in the Firing and Handling of Solid Fuels in Domestic and Industrial Boiler Plants," by R. Cleland. Scottish Branch. Scottish Building Centre, 425 Sauchiehall Street, Glasgow, C2. Tues., 28 Mar., 7 p.m.
LEEDS
Annual General Meeting. Yorkshire Branch. Great Northern Hotel, Leeds. Wed., 15 Mar., 7.30 p.m.

Institution of Mechanical Engineers

LONDON
"Running-in Practice for Internal-Combustion Engines": Discussion. Lubrication Group. Fri., 24 Mar., 6 p.m.*
Internal Combustion Engine Group Meeting. Mon., 27 Mar., 6 p.m.*
"An Experimental Study of the Flow Conditions and Pressure Drop of Steam-Water Mixtures at High Pressures in Heated and Unheated Tubes," by R. W. Haywood, C. A. Knights, C. E. Middleton and J. R. S. Thom. Wed., 29 Mar., 4.30 p.m.
BASINGSTOKE
"Development of Multi-Fuel Engines," by G. K. Martlew. Southern Branch. Technical College, Basingstoke. Wed., 29 Mar., 7.30 p.m.
BRISTOL
"Blade Profiles for Axial-Flow Fans, Pumps, Compressors, etc.," by Professor A. D. S. Carter. Western Branch. Engineering Laboratories, The University, Bristol. Tues., 21 Mar., 7 p.m.*
CARDIFF
"The Diesel Engine in Association with the Gas Turbine," by E. Chatterton. South Wales Branch. South Wales Institute of Engineers, Park Place, Cardiff. Tues., 28 Mar., 6 p.m.
DERBY
"Castle Donington Power Station," by J. O. Greaves, J. S. Hall and A. A. Parish. East Midlands Branch. British Railways Training College, Derby. Thurs., 23 Mar., 7.30 p.m. (Preceded by a visit to Castle Donington Power Station at 3 p.m.)
IPSWICH
"Common and Uncommon Causes of Failure of Plant in Service," by G. A. Cottell. Annual Meeting. Eastern Branch. Diocesan Hall, Ipswich. Thurs., 30 Mar., 7.30 p.m.
LINCOLN
"Powder Metallurgy Applications," by B. H. Swan. East Midlands Branch. Technical College, Lincoln. Thurs., 30 Mar., 7.15 p.m.

Institution of Mining and Metallurgy

LONDON
"Application of Probability in the Assessment of Flotation Systems," by D. F. Kelsall; and "Ion Exchange for Gold Recovery," by J. Davison, F. O. Read, F. D. L. Noakes and Dr. T. V. Arden. Geological Society, Burlington House, Piccadilly, W1. Thurs., 16 Mar., 5 p.m.*

Institution of Plant Engineers

CARDIFF
"Some Engineering Problems with Chemical Plant," by J. C. Veale. South Wales Branch. South Wales Institute of Engineers, Park Place, Cardiff. Tues., 28 Mar., 6.30 p.m.
SHEFFIELD
"Role of the Central Engineering Workshop in the Maintenance Problem," by G. C. Oram. Sheffield Branch. Grand Hotel, Sheffield. Thurs., 30 Mar., 7.30 p.m.

Institution of Production Engineers

LIVERPOOL
Annual General Meeting at 7.30 p.m.; and Film Display at 8.30 p.m. Liverpool Section. Exchange Hotel, Tithebarn Street, Liverpool 1. Wed., 29 Mar.
MANCHESTER
"Electrified Railway Freight Handling Systems," by G. R. Higgs. Annual General Meeting. Manchester Section. Manchester College of Science and Technology, Manchester. Mon., 27 Mar., 6.30 p.m.
SHREWSBURY
Annual General Meeting at 6.45 p.m.; and Film Display at 7.30 p.m. Shrewsbury Section. New Technical College, London Road, Shrewsbury. Wed., 29 Mar.
WOLVERHAMPTON
"Modern Trends in Metal Removing Techniques," by J. Cherry. Annual General Meeting. Wolverhampton Section. Star and Garter Hotel, Victoria Street, Wolverhampton. Thurs., 30 Mar., 6.45 p.m.

Institution of the Rubber Industry

MANCHESTER
"Extrusion Productivity," by T. J. Daniel. Manchester Section. Engineers' Club, Albert Square, Manchester. Mon., 27 Mar., 6.45 p.m.

Institution of Structural Engineers

LONDON
"Rubber-Tyred Overhead Cranes: Their Influence on the Design of Industrial Buildings," by E. M. Lewis. Thurs., 23 Mar., 6 p.m.*

Reinforced Concrete Association

BIRMINGHAM
"Models for Design and Research in Reinforced Concrete," by Dr. Geoffrey Brock. Midland Counties Branch. Joint meeting with the Midland Counties Branch of the Institution of Structural Engineers. College of Advanced Technology, Gosta Green, Birmingham 6. Fri., 24 Mar., 6.30 p.m.

Royal Aeronautical Society

LONDON
"Atomisation," by R. P. Fraser. Agricultural Aviation Group. Wed., 29 Mar., 7 p.m.

Royal Institution of Chartered Surveyors

EDINBURGH
"Scottish Developments in the Mining Industry," by Professor R. McAdam. Scottish Branch. 7 Manor Place, Edinburgh 3. Sat., 25 Mar., 9.45 a.m.

Sheffield Metallurgical Association

SHEFFIELD
"The Role of Ferro-Alloys in Modern Steelmaking Developments," by A. M. Sage. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 28 Mar., 7 p.m.

Society of Instrument Technology

LONDON
"Automatic Optimisation," by Dr. P. E. W. Grensted and O. L. R. Jacobs, at 5 p.m.; and "The Development of an Optimising Controller," by P. F. Sutherby, at 7 p.m. Control Section. Manson House, 26 Portland Place, W1. Tues., 28 Mar.
CARDIFF
"Feed Back," by R. S. Medlock. South Wales Section. Welsh College of Advanced Technology, Cardiff. Wed., 29 Mar., 6.45 p.m.
CHELTENHAM
"The Measurement of Vibration": Discussion. Cheltenham Section. Belle Vue Hotel, Cheltenham. Fri., 24 Mar., 7.30 p.m.
GLASGOW
"Report on the Moscow Congress," by Professor G. D. S. MacLellan. Annual General Meeting. Scottish Section. Scottish Building Centre, 425 Sauchiehall Street, Glasgow, C2. Fri., 24 Mar., 7.15 p.m.
MIDDLESBROUGH
"Some Impressions of Instrumentation in the USSR," by E. N. Martin. Annual General Meeting. Tees-Side Section. Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough. Wed., 22 Mar., 7.30 p.m.
WIRRAL
"Electromagnetic Flowmeters," by Leo. M. Bennett. Chester Section. Administration Building, The Associated Ethyl Co., Ltd., Oil Sites Road, Ellesmere Port, Wirral. Thurs., 23 Mar., 7 p.m.

Southampton Metallurgical Society

SOUTHAMPTON
"Metallurgy of Ferrous Welding," by Dr. R. G. Baker. Annual General Meeting. Southampton University, Southampton. Thurs., 23 Mar., 7.15 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901)
Building Centre, 26 Store Street, London, WC1. (MUSeum 5400)
Combustion Engineering Association, 70 Jermyn Street, St. James's, London, SW1. (WHItehall 5536)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, EC3. (ROYal 8493)
Institute of Metals, 17 Belgrave Square, London, SW1. (BELgravia 3291)
Institute of Road Transport Engineers, 1 Cromwell Place, South Kensington, London, SW7. (KENsington 3744).
Institution of Chemical Engineers, 16 Belgrave Square, London, SW1. (BELgravia 3647)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Engineering Inspection, 616 Grand Building, Trafalgar Square, London, WC2. (WHItehall 0818)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Mining and Metallurgy, 44 Portland Place, London, W1. (LANgham 3802)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Institution of the Rubber Industry, 4 Kensington Palace Gardens, London, W8. (BAYswater 9101)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128)
Reinforced Concrete Association, 94-98 Petty France, London, SW1. (ABBey 4504)
Royal Aeronautical Society, 4 Hamilton Place, London, W1. (GROsvenor 3515)
Royal Institution of Chartered Surveyors, 12 Great George Street, London, SW1. (WHItehall 5322)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)
Southampton Metallurgical Society. Apply to Mr. S. W. Hallwood, Folland Aircraft Ltd., King's Avenue, Hamble, Hants.

Report Writing Improves with Morale

Most engineers and scientists have to write accounts of their work from time to time. The effectiveness of their writing improves if attention is paid to certain factors of morale.

By B. C. Brookes, M.A., Senior Lecturer in the Presentation of Technical Information, University College, London

I HAVE had the opportunity of studying in some detail the writing of technical papers and reports in a number of industrial organisations. My introduction to the organisations has usually been by way of a request to give a course on report writing or some closely allied subject. As my experience has widened, I have come more and more clearly to realise that the situation in which bad report writing occurs is likely to be more complex than appears at first sight, and the possibility of there being factors other than the incompetence of the authors must be considered.

I have been forced to regard complaints about the technical writing within an organisation as possibly symptomatic of some deeper malaise. The difficulties are best explained by descriptions of some actual cases. I will first outline four illustrative cases and then discuss them in terms of the factors that can be isolated and identified. We shall find that the same factors may enter into more than one of the cases, and that all these factors are ultimately related to morale.

Case No. 1: The Manager Who Got Full Marks

My first doubts about the efficacy of the straightforward report writing course alone arose during a course I gave to senior engineers. The course consisted of lectures and group discussions, exercises and individual tutorials. One member of the course brought along his exercises for critical discussion at the tutorial but offered no point of criticism at all—a situation disturbing to a teacher! And the third time this happened, at only the third tutorial, I had to say that as he had got full marks so far I did not understand why he had bothered to come on the course and do his homework so punctiliously.

He replied that he was gratified to hear the compliment to his skill as a technical writer—he had cultivated the art for many years—but his reason for coming on the course was that he was very anxious to learn how to teach others. His real difficulty was not that he himself could not write tolerably well but that he had to write all the reports that emanated from the department of which he was manager. For years he had tried and failed to teach his juniors, but the young men of his department seemed to know nothing of English—he could not imagine what was done in schools nowadays—but what was worse, they did not seem to have the slightest shame in presenting the most illiterate documents for his approval. The result was that he had to spend more and more time correcting their drafts. The department was growing, his responsibilities were increasing, and yet he had to devote himself to chasing details like commas and split infinitives.

One can, I think, easily imagine the vicious circle that had become established in his department. A junior member would write a draft and pass it to the manager for approval, but however hard the junior had tried his chief would always be able to find some points to criticise. The drafts were never quite good enough. It is always possible to find fault if one wishes to, and the "manager with full marks" wanted to find fault. It was his way of asserting his authority and maintaining his position.

So he never fully explained to his juniors exactly what he wanted and they were unable to find the answer from experience, by trial and error, because everything they wrote was equally faulted. So, gradually, the young men had ceased to try to please their chief. As he was bound to alter everything they wrote, he might as well, from their point of view, alter their first draft as their second, their first rough notes as their final draft—and so on.

This case illustrates a situation which is more common in industry than it ought to be—a compulsion to correct, an absurd fussiness about the details of other people's writing.

Case No. 2: The Manager Who Kept the Boys Busy

In this case the work of the department was to provide an investigation and advisory service to customers of the parent company, a company interested in heavy machinery. When a customer asked for technical help, or complained of difficulties arising from his use of the company's products, the manager would send along to the customer one of the members of his staff to investigate the difficulty on the spot. The staff consisted wholly of engineers of various kinds—all of whom I met, and all of whom appeared to be well qualified, practically and academically.

Their investigation of a complaint might take an hour or two, or it could take days. The investigating engineer would of course report progress by telephone from time to time and would eventually return to the office to make a report—orally if urgent action was needed, but always in writing in due course.

The writing of the full report expected by the manager could be a difficult task. The engineer had to describe how he had come to diagnose the trouble and what remedies he had proposed; he had to discuss any difficulties that remained and to report on any unusual aspects he had observed. Copies of his report would eventually be sent to the technical sales department who wanted to be forewarned of possible new troubles arising from the company's products, to the development department who wanted to learn of any shortcomings in the company's products that indicated a need for improved specification, and to the research department who wanted to hear of any unusual features worthy of laboratory investigation. The report was therefore addressed to technical men demanding detailed and accurate descriptions of the difficulties in precise technical terms.

I was called in to this department because the manager complained that the draft reports he received were not as good as they ought to be. He rightly demanded a high standard of presentation with a logical development of the argument, a critical analysis of the problem, and clear assessments of the difficulty accurately expressed in technical terms suitable for the three different readers. The samples of drafts he showed me certainly failed to meet his specification. They were scrappy, casual, and obviously hastily written.

It was only during the report writing course itself that the main source of difficulty became clear. I found that the young engineers on the whole knew how to write, but the difficulty was that in normal working hours they were *allowed no time* in which to do their writing.

The manager, a dynamic personality with many years of experience of this work, could not bear to see young engineers sitting at their desks in his office and apparently not operating. For him, a man sitting still and not actually writing or telephoning or pushing his slide rule was clearly a man waiting to be sent out on his next assignment—and out on his next assignment he was sent, whether the report on his previous assignment was completed or not.

But even if the young man knew how to look busy and was not sent out immediately again, there was little hope of his being able to write a coherent report in that office—a large open office with engineers, secretaries, technicians and the boss himself milling around amid a clamour of telephone bells, telephone talk, and rattling tea-cups. I soon discovered that a young engineer would only rarely attempt to write his reports in the office. His reports were written as opportunity offered—in trains, in cars, in cafés, in pubs, and often at home after the children had been put to bed and while his wife enjoyed the television.

In this case everyone knew what was wanted but the required reports were not written simply because neither time nor place were allowed for their composition. Fortunately the manager was able to appreciate the situation when it was pointed out to him and he agreed to equip a writing room for the authors of reports—a quiet room with the necessary reference books at hand, a sanctuary where they could work without being disturbed by telephones, colleagues or secretaries, and without their pauses for thought being observable by himself.

Case No. 3: The Scientists Who Talked to Themselves

In the third case I visited a department of a large organisation—a department again concerned with problems which arise in the field. The young scientists and engineers who did the field work seemed to be well-qualified both practically and theoretically for their work. A single investigation might take several months, but again ample time was allowed for the field visits and for the practical work these visits entailed. Here, further, the manager appreciated the difficulties of composition and the young scientists had fairly good physical conditions in which to work—small separate offices in a new building.

But these scientists too were in trouble with their reports. I asked as usual to see a sample and found that in detail, in texture, the reports were on the whole much better written than most that come my way, though some faults were to be seen. But there were more serious faults. The reports were very long, rather complicated in structure, and very difficult to grasp as a unity.

Formally the reports were addressed to a senior member of the organisation, and usually copies were sent to units in the field where the investigation had been made. But it was difficult to imagine any reader or readers anxiously awaiting the publication of these weighty documents.

I then discovered how the reports came to be written and published. The investigator would prepare a draft. The draft would be submitted to the section head. The section head would normally make some criticisms and send it back. The corrected draft would then be submitted to the group head. The group head would normally make some criticisms and send it back. The corrected draft would then be submitted to the group head. The group head would normally make some criticisms and send the draft back down the line. When the group head had been satisfied, the corrected draft would then be sat on by a committee of three group heads who again would make criticisms and send it back to the wretched author to correct again. Eventually the head of the department would approve the report and it would be published. Elaborate as the procedure may sound, I have in fact simplified it in my description.

As, of course, all the members of the department were out in the field for a large fraction of their working time, this internal editing process could easily take a year to grind through its motions. And so, if the draft report had any

coherence and unity as a first draft, it soon lost it as the series of editors suggested the inclusion of this and the exclusion of that, the expansion of one section and the rearrangement of another, and so on. Meanwhile the miserable authors became more and more bored with this long-winded procedure, and more and more reluctant to spend any more care on the report as it became less and less recognisable as the job they set out to do.

But why had this elaborate editing system arisen? What happened to their reports when they were eventually published? There was, of course, the usual standard distribution to senior members of the organisation and to the few units in the field directly concerned with the work. But no one seemed to ask for extra copies and —most important of all—nothing ever came back. No one ever commented on their reports, no one ever thanked them, no one they met ever seemed to have read them, no one ever even told them how awful they were. There was just a cold stony silence—and they felt the silence. It could only mean, they felt, that their reports were not very good after all, that they needed more careful grooming, more correcting, more editing, more rewriting. Slowly the complex editing system was built up. Over the years their reports got steadily bigger and better, more and more divided into sub-sections, sub-sub-sections and innumerable appendixes—in short they became more and more unreadable, more and more useless.

My main task here was to persuade them to shorten their reports, to simplify and accelerate their editing system, to forget about the very senior members on the distribution list and to write for the practical men out in the field who could apply their findings directly.

Case No. 4: The Manager Who Wanted it in a Nutshell

The call for help in the fourth case came from the head of a small research section of a large company which manufactures what may be called electronic devices. The research done by this small section is fundamental and long-term —far removed from the kind of industrial research which is closely tied to the immediate development of the company's products.

The specimen reports are well written in the sense that their material is well organised, developed and displayed. The only faults noticed at a first reading were relatively trivial faults of texture which could possibly be dismissed as arising from differences in taste. But then, of course, I did not understand what these reports are intended to do. Their contents can be broadly described as involving modern and advanced techniques, mainly mathematical and statistical, and with detailed analysis; for industrial reports they are highly theoretical.

It may not now surprise you to hear that the difficulty about these reports is that no one outside the research group can understand them. and that the *senior* manager responsible for the group finds it difficult to tell *his* superiors what the group is doing. Why can't they just tell him in simple terms—in a nutshell—what it is all about?

Here again is a situation which is more common in industry than it ought to be, especially in research departments. The predicament is this: On the one hand, young men are appointed to do serious specialist scientific work; they are appointed to do this work because they are the best specialists in their particular subject that the company can attract. They accept the appointments believing that they will be able to devote themselves wholeheartedly to their scientific pursuits, that they will be allowed to continue working with that single-mindedness of purpose that enabled them to become the experts the company needed.

On the other hand, the senior manager's task is to interpret the group's work in terms intelligible to his senior colleagues and especially to indicate the commercial implications of their work. Obviously the work of this special research group has a bearing on the company's long-term commercial and financial policy; and the more accurately the company can estimate its long-term policies, the more confidently it can deal with current financial problems. So there is constant pressure on the research group to explain itself in commercial terms.

Unfortunately the members of the research group are not able to explain themselves in commercial terms: if they could, they would not be the specialists they are and must be to do their research job. Unfortunately, too, the senior men, though some of them may have had some technical training, and though they must all have some technical knowledge of the company's products, cannot understand the reports published by the research group.

So here we have, in effect, two groups, highly dependent upon each other, with a communicative gap between them. At present there is goodwill on both sides because the problem is only just beginning to emerge, and to be felt. Obviously, however, a solution must soon be found or there will be another case of frustration. Difficult as this communicative task is, it becomes much more difficult to achieve satisfactorily if the information has to be put in a nutshell.

Now let me briefly analyse the main faults as I see them; the factors which, other than the technique of the authors, seriously affect the quality of written reports. The most obvious one is:—

(1) Unsuitable Physical Working Conditions

Recently I visited a foundry in which non-ferrous metals are cast. My mental image of a foundry, until I visited this one, was of a dark and dusty interior excited by sudden outbursts of molten brilliance, as quickly dimmed by clouds of fumes. But this foundry was light and airy, sunlit and clean, and, as the foreman proudly said, one would have eaten one's dinner off the floor. These are the kind of conditions that manual workers are beginning to demand and to get; and there is a phalanx of factory inspectors to see that employers maintain minimum standards. What I would like to see now is equal attention being given to the offices in which young men are expected to write their technical reports; or preferably perhaps I would like to see writing rooms set aside for this purpose, rooms equipped with the necessary reference books and documents and sound-proofed against the peremptory clamour of telephone bells.

Bad writing conditions are not good for the scientific author's morale.

(2) Vagueness of Specification

Often when I have given a course of report writing I realise at the end that all I have done is to have helped the members of the course to discover for themselves *what* they should write and what their purpose in writing is—not *how* to write, for that I find they can usually do.

When the senior members of a firm complain about the quality of the reports they get from their juniors, what they mention are the minor faults of texture that arise from the authors' uncertainty of purpose: but what they are really complaining of is that the young men with one, two or a few years of experience, perhaps in a single department, do not understand the whole business of the company, its policies and its personalities, as they, the men of forty years' experience of it do.

Often I have to explain patiently to the seniors that their young men can learn to look after the commas and split infinitives themselves but that they would appreciate more guidance on the scope and structure of the papers they are asked to write and the purposes they should try to fulfill. It is often uncertainty of purpose that leads to the uncertainty of punctuation and the other trivial faults the seniors focus on.

Vagueness of purpose is bad for the scientific writer's morale.

(3) Slow Editing

My interest in any paper I am writing wanes very rapidly after completing what seems to me to be a satisfactory version. Perhaps I suffer from a one-track mind. But can you expect an author to be enthusiastic about a document that is returned to him for correction of arbitrary details at random intervals over a period of three years? Yet this happens.

This slowness to edit and slowness to publish is bad for the writer's morale.

(4) Denial of Responsibility

An editor should remember that every correction he makes or proposes is, beyond a certain limit, merely a means of denying to the author the responsibility for his work. When the process is taken to the extremes I have seen practised it is not surprising that young authors in effect wash their hands of the whole affair.

I have recently had to recommend to one organisation that the name of the young author be put on the front cover of the report along with the name of the organisation and department, and the name of its director. Formerly the author's name had been difficult to discover, lurking as it did in small type on an inner page.

Any denial of responsibility for the papers he writes is a denial of the author's status as a scientist and of his scientific right to publish his own work under his own name.

The denial of his responsibility and status is bad for the scientific author's morale.

(5) Criticism of Trivia

When a young scientific author has spent some months on a piece of research which has required scientific ingenuity and inventiveness, patience and perseverance, the application of all his technical knowledge and practical skills, when he finally unravels the tangled threads of the problem and laboriously sets down on paper the story of his intellectual adventure, it is chilling for him to receive from a remote senior scientist comments confined to subeditorial details. If he regards his chief as a senior *scientist* he expects to get *scientific* criticism. But, of course, *scientific* criticism, that is, criticism of his scientific techniques, or arguments or conclusions, is hard to get. The report has to be read carefully if its logical faults are to be detected, and such careful reading of scientific papers needs time and concentration.

Too much of our reading is at the sub-editing level at which we look *at* the words rather than *through* them to what is being said.

(6) The Nutshell Factor

The belief is widespread that anything, however complex, can be explained to anybody, however dim, in a nutshell. It cannot. Nutshell communication is possible only in the special case when the communicators have much common ground relevant to the subject in question and have a deep common interest in it. Though nutshells are small, they raise big and difficult issues—metaphysical, philosophical, ontological, epistemological—and I do not propose to embark on these now.

I mention the nutshell factor because I meet it often. It is particularly distressing for a scientist to be asked to put all his scientific knowledge—perhaps his life's work—into a nutshell for a layman who doesn't propose to make any effort himself towards understanding. The scientist cannot do it, and, as his attempts to reduce his knowledge to nutshell proportions are doomed to almost certain failure, the demand for nutshells is another cause of frustration.

To sum up, I have tried to identify some of the factors which induce a state of poor morale in industrial scientific authors. The authors do not always realise what is wrong—all they feel is that somehow they cannot write the reports expected of them and so they call for a course on how to write reports. In a very high proportion of the cases I have been concerned with, however, it has been one or more of the six factors I have isolated that have needed correction first. Even when a scientific author has an adequate writing skill it cannot be effectively applied unless the six factors all bearing on his morale are first eliminated.

Human Element

Engineering Training Examined

INCREASINGLY the changing practices of technology mean that qualified engineers who hold responsible positions in production or research have to equip themselves with fresh techniques, with new information and training.

Post University On-the-Job Training for Engineers is the title of a paper given to the Society of Automotive Engineers' International Congress, at Detroit, USA, in January, by E. J. Manganiello and Vincent F. Hlavin, of the Lewis Research Centre of the National Aeronautics and Space Administration.

The Lewis Research Centre has been active for 18 years in the field of aerospace propulsion. In its early years it was concerned with improving the performance of reciprocating engines and with associated problems of subsonic propulsion aerodynamics. Within a few years this had changed to turbojet and ramjet propulsion and supersonic flight.

The aerodynamics of propellers became the aerodynamics of high speed turbine and compressor blades. Fuel ignition and carbon deposition problems were transferred from a cyclical or intermittent high compression combustion chamber to a continuous combustion zone within a thin-walled metal shell. This transition required the same basic knowledge and principles as before, but Hlavin and Manganiello point out that it involved a variety of considerations not generally familiar to the scientists and engineers of the Lewis Centre.

Chemical and nuclear rocket concepts replaced the still recent turbojet engine research. The major concern of the Lewis Centre became not so much one of knowing where it was going but of reorienting the staff. The staff had always been encouraged to improve their educational backgrounds by on-the-job seminars, brief specialised lecture courses and graduate evening courses run by local colleges and universities. For the first decade of the centre there were no resources for the supplementary financing of such educational activities or extending them to a full post-university training programme in the centre.

Release Costs Money

The United States Congress acted in April, 1950, and passed the NACA (National Advisory Committee for Aeronautics, later NASA) Graduate Study Leave Act. The first training budget in support of those suffering salary losses in taking advanced courses at colleges was for just under $10,000 in the school year 1950-51. Eight years later this had risen to support for 51 scientists and engineers at a cost of $31,000.

Wider training opportunities were provided at the same time by the expansion of informal seminars and lectures at the centre into a series of formal graduate level courses developed round the centre's own fields of activity. Employee response was at the high level that could be expected. In the first year, 1953, there were 150 taking part. During 1960, 400 employees enrolled, about half of the professional research staff.

The breakdown of the centre's graduate training in the 1959/60 school year was 9 employees spending a complete year at graduate school, 158 on part time local college and university courses and 34 on short technical courses at institutes and at conferences around the United States. Costs for tuition and related fees were $50,000.

What is more important is that the training of 201 engineers and scientists lost some 33,000 man-hours, or some 3 per cent of the total research and engineering staff time. Manganiello and Hlavin confess that they cannot measure the return in specific terms. But they are sure that the intangible benefits more than outweigh the costs.

Post-graduate on-the-job training on the scale described by Manganiello and Hlavin is not by any means confined in the United States to the National Aeronautics and Space Administration. Facilities for further study of the kind they describe are looked for by many of the best graduates as they decide where to begin their careers.

There are signs of the same attention to further training becoming usual in the United Kingdom. In principle there is nothing new in the engineer keeping up to date as he goes along. As the pace of technological change increases the business of keeping abreast will grow in the amount of time, and money, it consumes.

Briefing Prospective Mechanical Engineers

The Education and Training of Professional Mechanical Engineers, the new booklet put out by the Council of the Institution of Mechanical Engineers, states that the education and training of mechanical engineers should include—"a sound general education including English . . ."

Just how necessary this is the booklet itself demonstrates on the second page. Explaining "What is Mechanical Engineering?" in three sentences, one of them using 59 words, is certainly an almost impossible task. By introducing no less than three e.g.'s into one sentence the explanation becomes, putting it gently, hard to follow.

The booklet is intended for those interested in making their career in mechanical engineering, as well as the better informing of careers masters, youth employment officers and headmasters. The section, "How are Mechanical Engineers employed?" tells how the engineers functions may include management, design, research and development, manufacture, assembly, operation and maintenance, consulting and sales, and teaching. Further references occur to supervisory capacity and to general management, then on to policy decision and "high administrative as well as technological ability."

This is all true enough, but how relevant is this abstract picture to the boy in the sixth form? If his mind is running in the direction of administration and policy, he may be turning towards the law, towards accountancy, towards reading for an arts degree.

The future mechanical engineer may well have a hankering after making things, after changing the material shape of his surroundings. Something of the spirit behind this might have made a useful appearance in the impression of what the mechanical engineer does.

The Council's new publication is admirably clear in setting out the function of the various qualifications. There should be no aspiring mechanical engineer, or advising career master, who is unable to discover from these pages, and a very helpful diagram, just the exact rung of the ladder on which to set his foot, and also to gather some idea of what lies at the top.

On practical training *The Education and Training of Professional Mechanical Engineers* (which is available from the Institution of Mechanical Engineers, 1 Birdcage Walk, London, SW1, price 2*s* 0*d*) says: "the provision of organised facilities for practical training is a responsibility of industry" and a little later "application should be made to the firm concerned."

It is not the job of the Council to spoonfeed boys and their parents but there was an opportunity here for a list of those firms large and medium, who lead the way in industrial training.

Post-Graduate Training for Electrical Engineers

For formal post-graduate study by engineers who have begun their careers in industry there are three main possibilities in arranging the courses.

There is the full-time course of perhaps one university session, the full-time course of shorter period, possibly one term, and there is the part-time course which may be pursued for one day in each week throughout a session.

Considering these three, the authors of the paper *The Place of Formal Study in the Post-Graduate Training of an Electrical Engineer*, which is to be published in the *Proceedings* of the Institution of Electrical Engineers, have come down in favour of the full-time course of limited duration. The authors, both equipped for their task with industrial and educational experience, are Mr. N. N. Hancock, of the Manchester College of Science and Technology, and Mr. P. L. Taylor, who is with AEI (Manchester).

The point that the constantly growing and changing body of engineering and scientific knowledge makes post-graduate study for the electrical engineers a matter of necessity needs no repetition. The important questions are how and when?

The place for further training must either be the works or an academic institution. Hancock and Taylor report that they find it difficult to think of any arguments in favour of the works. At the academic institution the basic facilities, lecture rooms, laboratories, libraries . . . will already be in existence.

In the matter of teaching, there would be a double advantage. A great part of the teaching could be done by the academic staff, supplemented, where necessary, by lecturers from industry. For academic staff there would be the advantage of teaching at a higher level than was needed for undergraduate instruction. This is stimulating for the instructor and presumably of indirect benefit to his undergraduate teaching work. For the teacher brought in from industry, there is the valuable discipline of marshalling his material and conclusions for the lecture room.

There have been full-time post-graduate courses lasting the full university session for some years. Hancock and Taylor conclude that, if there was a greater demand for them than, in fact, exists, a greater number of institutions would offer the courses than currently do so.

Perhaps a larger point is what the authors describe as industry's lack of satisfaction with the way in which the time available in a full session's course has been utilised. The usual division of a full-time post-graduate course into roughly the same proportions of lectures, laboratory classes, and private study and project work as in an undergraduate's course is criticised in industry on a number of grounds. If, it is said, mental training in undergraduate days has been adequate there is no longer the same need for long private study periods. Nor is the original undergraduate need to place emphasis on project work still quite so valid.

The authors ask the important question—are the full sessional courses educationally desirable, especially now that grants on a substantial scale have been introduced, and are intended to be not incomparable with the salary of a graduate apprentice? Hancock and Taylor arrive at the conclusion that such a course will be most suitable for men who wish to undertake a lot of post-graduate study. They see the danger that the existence of the courses will make the universities less willing to accept the industrial view that at present post-graduate study should be relatively intensive for a shorter period than a full session.

Hancock and Taylor are not very happy about part-time study. They point out its capacity to immobilise near one academic institution apprentices who are with firms that would normally be giving them wide experience by posting them progressively from one factory to another in the group.

On top of that, there is the break between studies, making for wasted effort in recapitulating each week what has gone before. There is also the continuous interruption of the individual's industrial work. Experience has shown that students prefer, and work better with, an uninterrupted period of study.

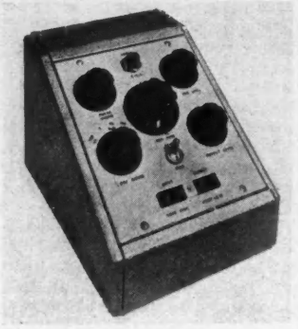
For a significant proportion of graduate electrical engineers, the authors conclude, there is a need for organise post-graduate study as part of a two-year apprenticeship, and that it should be full time, lasting for about one term, and held at a university. Before such courses can be made widely available the necessity to examine closely the arguments in the case is acknowledged.

Relaxation After Study

Engineers have followed the medical, dental, teaching and other professions by starting a Wine Club. It will give them spirits at 2*s* to 2*s* 6*d* per bottle less than retail prices; sherry, port and brandy from 2*s* to 5*s* less; and table wines at least 10 per cent less. For further particulars, write to the Engineers' Guild. 201 High Holborn, London, WC1.

TRIGGER GENERATOR

Portable



Now announced is the type M640 high voltage generator for producing triggering pulses.

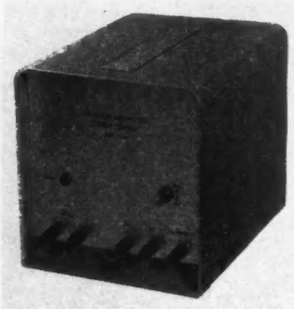
The instrument uses semiconductors and printed circuits so that the power consumption and bulk are both reduced. It is also claimed that the load capacity has a negligible effect on the rise time: in fact the only effects are a small reduction in the size of the output pulse and a slight shift in the pulse recurrence frequency. Both positive and negative going pulses are available. Facilities are provided for synchronisation and triggering by an external signal.

The available functions are free running operation, synchronisation of the free running condition, triggered operation with variation of the trigger level threshold and single cycle operation by push button. The set is completely portable being powered by two 67·5 V dry batteries. It may also be operated from a separate mains supply unit.

The free running range is from 10 to 100,000 pulses per sec, and the triggering range from dc to 50,000 pulses per sec. The output voltage is continuously variable from 0 to 65 V, the output impedance being 500 ohms maximum. The output waveform is a differentiated spike. A choice of four pulse widths is offered of 1, 10, 100, and 1,000 μ sec, with a rise time of less than 0·15 μ sec even when fully loaded. Current drain is from 1 to 10 mA depending on the control setting. *Winston Electronics Limited, Shepperton, Middlesex.*

POWER SUPPLY

Very High Stability



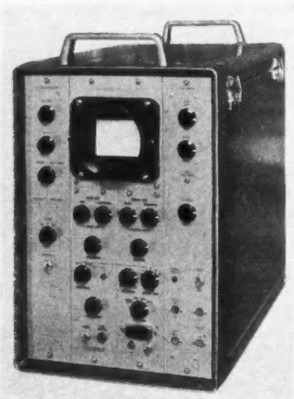
Primarily developed for use with the Unicam SP 500 spectrophotometer, the power supply unit 115D produces a very stable direct current supply.

The 6V output is for driving the tungsten filament lamp of the instrument. The power unit employs a conventional stabiliser system, a compensating double zener reference being used to provide a high degree of stabilisation. Particular care has been taken to minimise the temperature rise of the sampling and control components due to the heat dissipation in the series regulators. The use of the latest type of power transistor together with cast alloy heat sinks permits the unit to operate in high ambient temperatures and under adverse mains input conditions. The components are suitable for use in all climates.

Three outputs are provided: 6 V dc at 6 A maximum; 6 V dc at 100 mA maximum; and 2 V dc at 100 mA maximum. Output resistance is less than 0·005 ohms at 6 V and approximately 1·3 ohms at 2 V. The stability factor is greater than 1,000 to 1 for input voltage variations of −15 to +20 per cent. Ripple and noise remaining in the output is approximately equal to 3 mV measured peak to peak. Power supply requirements for the input are 90 to 130 V or 220 to 240 V, at 50 or 60 cycles. The case measures 9½ in by 9¼ in by 12½ in, and the whole unit weighs 20¼ lb. *Labgear Limited, Cromwell Road, Cambridge.*

TELEVISION MONITOR

Still Picture at any Instant



The Tele-Remscope is a television monitor that will retain a still picture for up to a week.

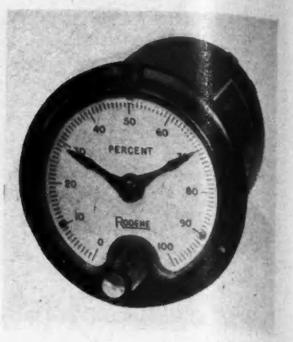
Its use extends the range of observation possible with closed circuit systems. The still picture may be selected at any instant from the moving sequence, and is available for immediate viewing. It can be studied for about 10 minutes and can be erased when no longer needed. If necessary, the picture can be retained with very little deterioration for up to a week even with the instrument switched off; it may be viewed again within a few minutes of switching on.

The instrument will work on the British, European or North American closed circuit television standards; any number of fields from 1 to 4 may be retained as required. The selection of the image to be stored may be made by a push button, by closing an external pair of contacts, or by feeding a pulse into the unit. Normal monitor operation is provided to facilitate adjustment. Particular applications include the remote inspection of objects in hazardous areas.

The tube is 10 cm diameter with yellow fluorescence. Resolution is 40 lines per cm. Erase time is less than 1 second. Video band width is 0 to 4 Mc/s and the weight is 110 lb. *Cawkell Research and Electronics Limited, Scotts Road, Southall, Middlesex.*

BATCH CONTROL

Constituent Timer



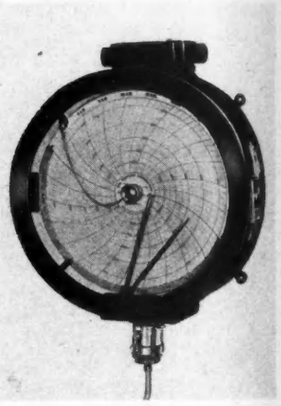
The opening time, and therefore the delivery, of a hopper in a batch mixing plant can be controlled by a Rodene timer.

When a fixed capacity mixer is used, the quantity of material from each supply hopper can be considered as a percentage of the whole. Accordingly, these timers are calibrated in percentages. The total of the individual timers on each hopper should of course equal 100 per cent and to ensure this, each timer has an accurate potentiometer geared to the pointer. These potentiometers are interconnected so as to show on a moving coil meter the total of their settings. The circuit can also be arranged so that the plant cannot be run unless this meter shows 100 per cent.

These timers have variations in contacts to allow many methods of operation, but for batching they can be set to start on the receipt of a pulse; to close a contact for a timed period; and to give out another pulse at the end of the timed period to start the next timer in the chain. The timers will not reset on mains failure as the clutches can be made for dc operation, so that should a batch be interrupted by a mains failure, delivery will be accurately completed when the supply is restored. Setting is carried out by a knob which moves a pointer to the required figure; a second pointer moves round to show the progress of the timing period. *D. Robinson and Company Limited, 5-7 Church Road, Richmond, Surrey.*

TEMPERATURE CONTROLLER

Recording Impulse Type



Recently announced is the model RES recording impulse type thermostatic controller.

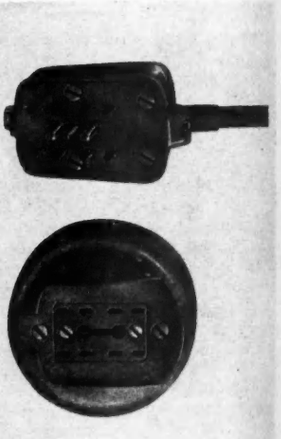
This proportioning recorder controller, made by the Partlow Corporation, is designed for use where process temperatures are critical and overshoot (or undershoot) cannot be tolerated. It is also recommended where the capacity of the electrical heating elements is large in relation to the work load, under which conditions two-position controllers may give serious overshoot.

The model RES provides variable electric input to the controlled equipment so that changes in temperature within the modulating range automatically produce proportional changes in heat input. Current is supplied in timed impulses by means of a constantly rotating cam which cycles a snap action switch in the control circuit. It is claimed that as a result the time/temperature curve approximates a smooth line without peaks until the required temperature is reached.

The normal modulating range of the instrument is 8 per cent of scale range. In use, the RES records process temperatures throughout the cycle on a 10 in diameter calibrated chart, which is then available for reference. *Ad. Auriema Incorporated, 85 Broad Street, New York, NY, USA.*

MULTI-PIN CONNECTORS

Non-Interchangable



Type 59 connectors are multi-pin units mainly for telecommunication purposes.

A special feature is the provision of two locator pins, each of which has had one side made flat. By positioning these flats, a total of 16 different combinations is possible which are not interchangeable.

Between the two locating pins is a spring loaded catch that normally holds the plug in place. It is released by a button on the end of the plug, in which provision has been made for inserting a wire type lead seal, so that it is possible to seal a plug in position if required. Colour coding by paint spots indicates mating plugs and sockets.

The socket shown in the illustration is 2⅜ in diameter and stands 1¼ in high. A flush mounting box is also available. Individual terminals in the socket box can be connected by bridges according to the wiring system and, in addition, the contact springs have solder tags which can be used for the connection of resistances or as extensions of the contact bridges. Two break contacts operated by the pins are also included. *British Sarozal Limited, 22 Berners Street, London, W1.*

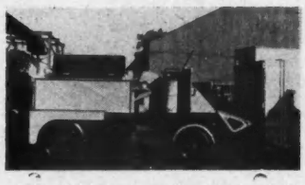
MASTIC ASPHALT TRANSPORTER

Gas Fired

RECENTLY put on the market is a transport vehicle for mastic asphalt, the heating being by liquid petroleum gas.

One of the claims is that this form of heating is cheaper and cleaner than coke firing. There are fewer spare parts and there are no firebricks or fire bars. The transporter has a capacity for 45 cwt of asphalt.

The gas fired equipment is designed for use with liquic gas, the standard model having jets suitable for propane, but jets for butane are also available. The unit is designed with automatic control by thermostat and a flame failure device is fitted to ensure safety of operation. Standard machines are built to accommodate two 40 lb gas bottles which are so placed that warm air from the engine circulates round them when the cooker is in use. The standard 45 cwt model heats the full charge from cold to 450° F in approximately 3 hours using from 40 to 45 lb of gas.



The transporter is mounted on a straight chassis and equipped with pneumatic tyres on roller bearing hubs and cable operated brakes. A servo cylinder can be fitted if required. The inner mixing pan is 6 ft long by 2 ft 9 in wide by 2 ft 10 in deep and is made of ¼ in mild steel plates welded to ⅜ in end plates. The pan is fitted with lids of ⅛ in plate equipped with handles, the lids being hinged to a centre member running the length of the pan. Lagging is clipped to the lids by a plate. The outlet is an oval type treacle valve with an 8 in by 6 in opening and launder for discharging the material clear of the gas burners. The stirring shaft is made of 3½ in square mild steel and has cast iron bearings. Cast steel arrow head type stirrers are incorporated. The loading height of the pan is only 5 ft, making for easy operation. *Braham, Patterson and Benham Limited, Straysfield Works, Clay Hill, Enfield, Middlesex.*

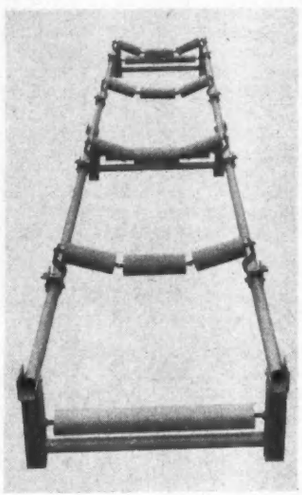
CONVEYOR FRAMEWORK

Tubular Construction

A CONVEYOR framework of tubular construction is designed to give resilience to the belt.

Another advantage is that the members can be easily and neatly packed to facilitate transport underground. The framework is the open type, has no cover sheets and may be speedily erected and dismantled. For belt widths up to and including 30 in the stools are set at 10 ft centres and the idlers at 5 ft centres. For belts of 36 in and 42 in width the stool centres are reduced to 9 ft and the idlers to 4 ft 6 in.

The resilience allows the belt to form a deeper trough as the load increases, thus decreasing the risk of spillage, the actual depth being determined by the weight. The give in the idler is provided by a rubber cushioning block mounted between the stringer tube and the bracket. The maximum deflection is approximately 2½ in. The centre idler is pin-jointed to the winger spindles which, in turn, are hooked in position. The support brackets allow the framework



to be slung from the roof by chains. Allowance is made for lateral adjustment of the idler sets. *Richard Sutcliffe Limited, Horbury, Wakefield, Yorkshire.*

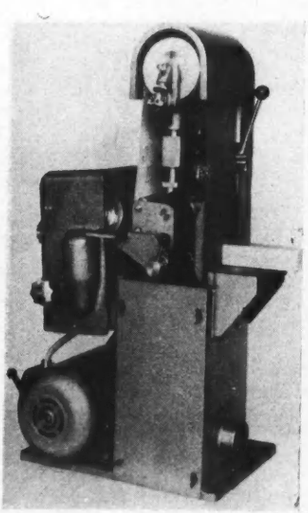
BELT GRINDER

Automatic Operation

CENTRELESS grinding can be carried out automatically on the Loeser belt grinder model RS 340.

The machine also has facilities for a vertical grinding face at the rear as shown in the illustration. Rod for centreless grinding is fed in on the left and carried forward by the infinitely variable speed feed gear. Variations are obtained by altering the slant of the drive wheel and cover speeds from 5 to 20 ft per minute. Capacity is up to 2 in diameter and a 6 in belt is the maximum that can be fitted.

Belt speed is 5,500 ft per minute using a motor rated at 2·2 kW. The direction of running can be reversed. The feed is driven through worm gears from the belt drive using a universal joint or, alternatively, a geared motor can be used. Belt tension is adjusted by means of two tubular guides with spring loaded suspension. The eccentric pretensioner can be replaced to shorten the distance between the two pulleys if desired. Different springs can be fitted to the suspen-



sion to obtain the best surface finish according to the material. *Addison Tool Company Limited, 28 Marshalsea Road, London, SE1.*

UNIVERSAL BRIDGE

Resistance, Inductance and Capacitance

SIMPLICITY and stability are two claims for the TF868B universal bridge.

A single dial is used for the measurement of resistance inductance and capacitance; changing the setting of the function selector or range switch automatically changes the calibration of the dial so that the instrument is always direct reading. For resistance measurements the circuit elements are connected as a Wheatstone bridge. Inductance and capacitance are measured by comparison with a standard capacitance in RC ratio arm bridge in which the final arrangement depends on the losses.

The phase balance control carries two scales—one marked for Q and the other for tan δ. The scale in use is selected by the changeover switch which selects the final arrangement of the "standard" arm of the bridge. The two scales give a continuous coverage of Q up to 1,000 and tan δ up to 10. There is automatic detector sensitivity control, the detector being a three stage selective amplifier and diode voltmeter.

The range of inductance measurement possible is from 1 μH to 100 H in 7 decades at either 1 or 10 kc/s. Capacitance is from 1 μμF to 100 μF also in 7 decades and also at the two frequencies, while resistances from 0·1 ohm to 100 megohms can be measured in 8 decades at direct current input. The unit will operate from standard mains supplies of 200-250 V or 100-150 V, 40 to 60 cycles, with a consumption of approximately 25 W.

A dc choke adaptor enables up to 200 mA from an external supply to be passed through inductances under test. *Marconi Instruments Limited, St. Albans, Hertfordshire.*

FACE SHIELD

Practical and Aesthetic

THE CLEARWAYS face shield illustrated is claimed to satisfy both practical and aesthetic requirements.

In particular it is claimed that the head band and fitting will not be detrimental to hair styles, and the shield can therefore be used by women workers. The shield consists of a headband and brow guard with a detachable flip up vizor. The bands are said to distribute the weight evenly over the head without pressure or tension. The band is made of lightweight fibre with an adjustable elastic loop at the back.

The tough brow guard is made of Celastoid providing spark and flash deflection and is available in a choice of six colours. The detachable vizors are also made of Celastoid with a rigid aluminium edge binding for additional strength. They are fitted by press fasteners inside the brow guard to prevent liquids running down the rear of the vizor and will fit easily over prescription type eyeglasses. The vizors will swivel up when required. Three

depths are made, 4, 6 and 8 in and two thicknesses 0·03 or 0·04 in. *Safety Products Limited, Holmethorpe Avenue, Redhill, Surrey.*

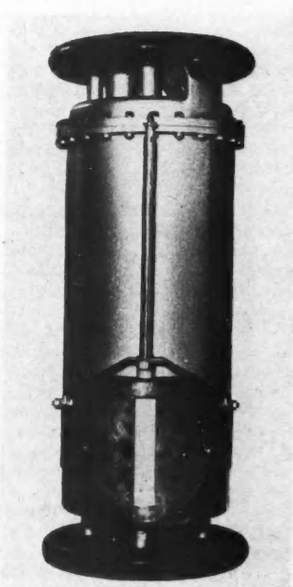
X-RAY UNIT

Low Weight and Portable

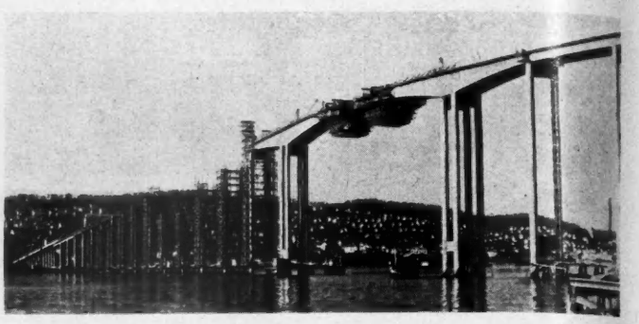
THE BALTOSPOT G150 is a lightweight portable X-ray unit of 150 kV capacity.

It is made in two models, one with the type D head which has a field of 60° and the other with type P head having a field of 360°. In both units the beam angle is 35° and the head is offset. The focal spot size of the tungsten target is 1·5 mm by 1·5 mm in the model D, and 0·8 mm by 2·1 mm in the type P. The offset head is particularly useful in the examination of closed vessels of small diameter, the examination of a 3 ft diameter tubular vessel with welded dished ends being well within its capacity.

Cooling is by sulphur hexafluoride with a thermoswitch to guard against excessive temperature rise. The length of the tankhead is 1 ft 9 in long by 8¼ in diameter weighing 46 lb. With end rings and cradle the total weight is 58 lb. The control unit operates from a 220 V 50-60 cycle supply, draws 6 A and weighs 27 lb. *Pantak Limited, Vale Road, Windsor, Berkshire.*



Northern Europe's longest prestressed concrete bridge at Tromsö.



The centre span, over the shipping lane, was built as free cantilevers.

New Contractor Found no Snags with Dywidag System

The Tromsö Bridge, in Norway, 3,410 ft long, is the longest prestressed concrete bridge in Northern Europe. It crosses Tromsö Sound, linking the town of Tromsö, on a small island off the north coast, with the mainland. From the square in Tromsö, on the left of the first illustration, the bridge runs straight for 2,024 ft, rising to 136 ft above sea level at the centre span, and thence to the mainland in a gradual curve.

The carriageway on the land approaches to the bridge is supported by a single line of columns, but the beams over the sound are carried on pairs of columns combined into a frame structure by cross members at the top and 18 ft above the level of the water. Double pairs of supports carry the centre span. All the columns are of precast prestressed concrete, have a circular section, a wall thickness of 8 in and an outside diameter of 3 ft 9 in. For the double supports at the centre, the columns are solid, but the other pairs are solid only up to the lower of the cross members and the single columns on land up to 10 ft above the main water level.

Ordinary concrete foundations are used on land. In the Sound the foundation consists of 12 in square precast concrete piles driven 40 ft into the ground. In all, about 600 piles have been used.

The centre section of the bridge, consisting of a 263 ft long main span and two side spans of 80 ft, is constructed of prestressed concrete according to the Dywidag system. The side spans were cast on fixed framework but the central span was carried out as free cantilevers without the use of fixed scaffolding, as shown in the right hand illustration. Construction progressed in 10 ft sections with each section anchored by Dywidag prestressing cables to that part of the cantilevers already completed.

The navigable channel beneath the main span is 197 ft wide and the bridge provides headroom of 125 ft. To prevent ships colliding with the piers of the centre span, concrete protection fenders built on prestressed concrete piles have been constructed.

The whole of the prestressed concrete work on the bridge is reported to have been carried out quickly and effectively, without major snags, by a contractor who had no previous experience of similar construction methods. For each of the 10 ft long sections the formwork was placed, reinforcement inserted, concrete cast, the rods tensioned and mortar injections carried out in a week, so that the whole of the cantilevering construction took about three months. The construction of the bridge was started in December, 1957. All the underwater work was finished in May, 1959; in October 1959 the casting of the main span was completed, and in March, 1960, the bridge was open to traffic—about eight months before the revised time of the contract and about four months before the original time contracted for.

Disused Railway into Motorway

Proposals to make use of a six mile length of disused railway track as part of the route of the Durham motorway are soon to be published by the Minister of Transport. Adoption of this proposal will permit Darlington and Barton to be bypassed with a minimum of interference with agricultural land and be a variation from the original route published in 1957.

Several advantages accrue from the translation of rail track into road routes. Railways generally have good alignments, easy gradients and large curvatures, all of which are well suited to road requirements; and consolidation of the sub-grade is completed so that the possibility of settlement is minimised. A number of projects now exist in the country for such conversions.

The Durham motorway, 30 miles long, will form part of the general modernisation of the Great North Road which the Ministry have undertaken between London and Newcastle upon Tyne, and the Minister has appointed the Durham County Council as his agents to carry out detailed preparatory work for the Darlington bypass. Construction of the motorway, which is to have dual two-lane carriageways, is to start as soon as the preparatory work is completed and funds are available.

Skycranes as General Transporters

During the early part of the 1960-70 decade, helicopter cranes of 8 to 12 tons payload are likely to become operational with the American armed services. Commercial operations during this period will probably consist of construction work in undeveloped areas, the transport of objects whose size otherwise keeps them off existing routes, and possibly as feeder services to main route terminals. By the mid-1960's, the passenger pod should be sufficiently developed that the helicopter crane can be employed as a commercial passenger carrier during peak periods. Larger cranes of 20 to 40 tons capacity will not make their appearance before the end of the 1960's.

These forecasts were put forward by Mr. W. W. Lysak of the Sikorsky Aircraft Division of the United Aircraft Corporation, Stratford, Connecticut, in a paper entitled "Progress in Skycrane Development" presented to the Society of Automotive Engineers' international congress at Detroit in January of this year.

Mr. Lysak described how his company had first developed the S-60 to study the concept of the helicopter crane and how they were now engaged in building the S-64, a turbine-powered crane. The illustration shows the three principal means of coupling the payload to the crane:

By a built-in winch, the hook being lowered to engage and lift payloads from the ground;

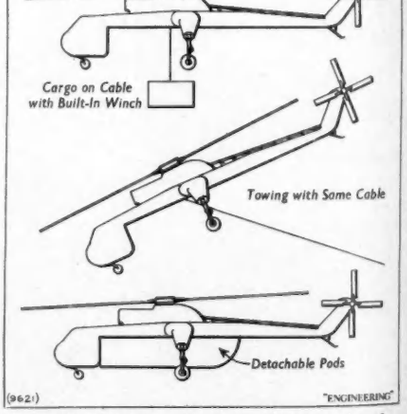
The winch cable and hook arranged for towing purposes; and

A series of handpoint fixings on the underside of the fuselage to accommodate pods or pallet loads.

Precise control over the load, and over the point of delivery, has been made possible by the use of an aft-facing control position, augmented by automatic stabilisation equipment (ASE). The pilot has a clear and direct view of both the external load, the aircraft and the landing point. With ASE, close control of the load is expected, even in winds of 20 to 30 knots.

Nose-wheel alighting gear has been adopted for the S-64 because it provides better towing facilities and less obstruction to fixing pods beneath the crane. Ground clearance on the S-64 is 112 in, which will readily accommodate the standard 8 ft by 8 ft cross-sectional containers being used by the USA armed services and also the European standard cargo container being developed from railway flat-wagon and road underpass dimensions. When used as a short-haul heavy lift vehicle, the S-64 will carry an 8 ton payload in both directions on a 40 nautical mile haul against a 20 knot headwind.

The conclusions of the author are that the skycrane offers possibilities not only for awkward erection jobs but as a versatile transport machine, requiring no access road for the pick-up and delivery of cargoes of any reasonable size or shape at virtually any spot on the globe.



The S-64 Sikorsky skycrane, showing the three principal ways of coupling the load.

Flame Cleaning 60,000 sq. yd of Steelwork

The largest flame-cleaning job yet carried out on a bridge in this country is now in hand on the Runcorn-Widnes bridge. The bridge contains the longest single span arch in Europe—1,082 ft—and the crown of the arch is 280 ft above the Mersey. Altogether, 5,000 tons of steel, involving

Flame cleaning a high point on the Runcorn-Widnes bridge.

a surface area of 60,000 sq. yd, are to be treated. A gang of ten men are doing the work. On the Runcorn side, the steelwork up to the top of the arch has been descaled and the first coat of paint applied.

The work is being done by the painting contractor, Thomas Cotton Limited, of Mansfield, using the British Oxygen process and equipment. Flame cleaning helps to remove the scale quickly, leaving the steel surface clean and dry. A good bond is thus obtained between the paint and the steel and, for the best results, the paint is applied while the metal is still warm (around 100° F); at this temperature the paint is thinned and is the better able to enter the small surface irregularities.

The bridge and the erection problems have already been described (ENGNG., 21 July '60, vol. 190, p. 148). The main contractors for the steelwork are Dorman Long (Bridge and Engineering) Limited and the consulting engineers Mott, Hay and Anderson of London.

Effects of Frost on Concrete

Frost notoriously impairs the strength of concrete. The alternating freezing and thawing reduces the strength of the concrete with time in a way which varies with the aggregate grading, cement content, and water/cement ratio. Tests at the Politechnico di Milano, Italy, have produced a new parameter for predicting the life of concrete subjected to alternate freezing and thawing.

Hitherto, the most widely used test for assessing the strength of concrete under these conditions was an ASTM test based on the measurement of Young's modulus by vibrating a suitable specimen. The modulus is related to the transverse frequency of vibration by the expression $E = CWn^2$, where C is a coefficient depending on the shape of the specimen, W its weight in lb, and n the frequency of vibration in cycles per second. The prediction of the life of concrete that is frozen and then thawed out at fixed temperatures and at predetermined periods is based on the assumption that, between the modulus and the compressive resistance, R, there is a fixed relationship, $E = hR$; and that by determining the modulus after a number of cycles of freezing and thawing, it should be possible to find the parallel falling off of the ultimate strength.

The Milan tests measured both the modulus and the strength of six types of concrete of very different mix and the following observations were made.

1. Determination of Young's modulus alone does not seem to be sufficient to predict the effects of alternate freezing and thawing for different mixes.
2. There is a difference between the modulus found immediately after removal from the refrigerator and that determined after a period of thawing.
3. This difference between the moduli increases with the sensitivity of the concrete to freezing; with concrete that is affected little or not at all by freezing, the difference is small and may even be nil.
4. The difference is apparent from the first cycles and the extent gives an early indication of the ability of the concrete to resist subsequent freezing cycles.

If the initial modulus, E_i, is found and then the value, E_n, after a limited number of cycles, a parameter

$$K = \frac{E_n - E_i}{E_i}$$

can be obtained from which it is easy to ascertain the strength R_f after a 100 cycles or so. It was found that R_f could be related to the initial strength of the concrete, R_i, by using the expression

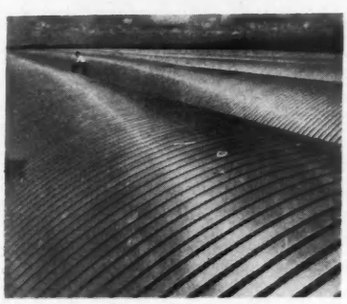
$$R_f = R_i \left(1 - \frac{K}{2}\right)$$

Analysis of the Milan tests on this basis showed a much closer agreement than did the use of more conventional formulae and, moreover, it was found that the life prediction could be made much quicker. (*European Technical Digest No. 4060*)

Aluminium Roof for Reservoir

A 16 million gallon service reservoir, nearly four acres in extent, has been completely covered with a barrel-vault roof of troughed aluminium sheet at Weeton, Lancashire.

When considering renovation of the reservoir, the owners, the Fylde Water Board, decided that roofing was the only way to eliminate the pollution of the water that has been experienced since the reservoir was opened in 1863. This pollution has included serious infestation by shrimps and midge algae, and by the droppings of seagulls. Attempts to keep the seagulls away had not proved successful.



Four acres of aluminium sheet barrel vault roof over a reservoir.

In selecting the roof form, cost and floor loading were the most important factors and corrugated aluminium was found to fulfil the requirements. The reservoir is circular in plan and has sloping sides of gradient 1 in 1½. Apart from the roof, improvements have included covering the floor and sides with concrete and slabs, 6 in thick, were cast on the floor and a 4 in layer placed over the sides. Cast concrete bases laid on the floor support the longitudinal prestressed beams of Y section that carry the aluminium sheeting.

The roof covering is 16 swg Noral deep trough industrial sheet (Noral 3S—BS1470:NS3), of which 125 tons were supplied by Alcan Industries Limited of Banbury. The span of each arch is 16·44 ft and the rise 3·35 ft. Aluminium alloy hook bolts, with aluminium and neoprene sealing washers, were used to fix the sheets to the valley beams, and the corrugations at the springing of each arch were filled with a profiled rubber edging strip. Side laps are two corrugations wide and the joints made with $\frac{5}{16}$ in diameter alloy seam bolts and nuts. At the ends of each avenue of arches a brick in-filling has been used incorporating a small ventilation panel.

Erection was carried out by direct labour and it was found that handling and assembling methods were quickly learnt by unskilled men.

Building Units in Aerated Concrete

Reinforced roof, wall and partition units are now in full production at Thermalite Ytong's Birmingham factory. Like the earlier Thermalite blocks, the new units are made of aerated concrete, with all the advantages of low weight, high strength, high fire resistance and good insulation properties.

The roof and wall units, with dry densities of 40 and 30 lb per cu. ft respectively, are made in 18 in widths, a variety of thicknesses between 4 in and 9½ in, and of standard lengths up to 20 ft. Partition units (30 lb per cu. ft) are 3 in or 4 in thick and 18 in or 20 in wide, and are available in standard lengths up to 10 ft, or to special requirements. All the units are cut to shape with a wire cutter and have a smooth surface which can be either rendered or painted direct; alternatively, spray plaster finishes may be used.

Thermalite Ytong are a member of the Laing group of companies and claim to be the country's largest producer of high-pressure steam-cured aerated concrete. Thermalite as a material consists of Portland cement, sand and pulverised fuel ash and was first produced by Laing in 1950. In 1955 an association was formed with International Ytong Company A.B., of Stockholm, who have a long experience of this type of manufacture and application on the continent.

Safety Post for Road Verges

A rubber or neoprene post for marking road verges has been introduced into the United Kingdom by Hamilton Limited of Cullingtree Road, Belfast. Not only do these posts cost less than the concrete posts, but in the event of being hit, they give way without inflicting any damage and then spring back into position.

The posts are 18 in to 2 ft long, reinforced at the base for fixing into concrete kerbs and have a core consisting of a spiral steel spring. At the top is a reflecting foil which is visible even in fog or heavy rain. A number of the posts have already been erected along a new stretch of road in Northern Ireland and have received favourable comment from the local authority and police, on account of their both low cost and safety characteristics. The makers have taken out a provisional patent and are marketing the posts as Hamilton Safe Sines. A UK agent is still to be appointed.

Nationalisation Takes a Different Twist

In his second article, explaining the background to the German economic "miracle," the author compares the differences between Germany's state-owned enterprises and Britain's nationalised industries. The first article appeared in ENGINEERING, 17 February, p. 249.

By Jossleyn Hennessy, M.A.

NATIONALISATION in the United Kingdom remains, at any rate for the time being, a subject of political controversy.

But since our nationalised industries play a major role in the economy—as much as £6,827 million have been invested in them between 1948 and 1958, i.e., no less than 26 per cent of our total investment—it is worth an attempt at an unemotional economic analysis to learn what we can from Germany's postwar experience of state enterprise. It is not generally realised that the state-owned sector in Germany is comparable in scale to ours. Its impact on the economy has, however, been very different.

To clarify the issues: it is argued for nationalisation that, where privately owned industry is not subject to public control, the community's interests are unprotected; that shareholders, who nominally appoint directors, are too dispersed to control them, so that boards become self-perpetuating oligarchies, with no incentives to efficiency; and that the government must retain control over the "commanding heights" of the economy.

Accordingly, the basic question is: how can directors be made accountable to the community? Two ways have been tried. First, under free enterprise. Here, those responsible for management are clearly identifiable. Although shareholders may seem passive, they perform two functions: they save and they invest according to their estimate of how their hopes of an income can best be attained. If shareholders are to perform these functions, companies must pay out maximum dividends, consistent with business reserves. In the early post-war years in Germany, when savings were short, companies were given tax exemptions to encourage them to plough back profits. But this course was soon modified, because it was held that, if directors plough back on a large scale, they assume a responsibility of which they are not the best judges, namely, how savings can best be allocated between firms and industries. Companies are biased in favour of their own prospects, whereas shareholders examine the whole market before they invest. Nor is it advantageous if the level of dividends is kept down, because this artificially depresses the market value of shares, hinders the assessment of risks, and impedes the raising of new capital.

NATIONALISATION ACTS

The second way of trying to ensure the accountability of directors is nationalisation. In the United Kingdom, the Nationalisation Acts vest the control of gas, electricity, coal, and so on, in independent Boards, broadly free from ministerial interference. The Boards were not placed under the direct control of Parliament in order to lessen the risk that business decisions would be influenced by political interference; for example, to close a factory might be economically sound but electorally disastrous. Clearly, the Boards could not be chartered monopolies, exploiting the community; Ministers had to be given some control and Parliament had to be free to criticise. In practice, control is limited by lack of Parliamentary time, and there is an imprecise balance of power between the Boards, the ministries, and Parliament. It is impossible to pinpoint accountability because it depends on the interplay of personalities, departmental committees, and party warfare. The members of the nationalised Boards have, in fact, far less scope for business enterprise and to adapt themselves to new circumstances, than have the directors of a private company. Nor can a minister, who chances to be enterprising, intervene in any but broad questions of policy.

In other words, whereas accountability in Britain's nationalised industries lies in a shifting no-man's land of Parliament, Government, and the various independent Boards, accountability in a private company is clear. The directors must produce goods saleable in a competitive market; poor management means poor dividends which depress the value of their company's shares and make it difficult to raise capital for expansion. Persistence in poor management leads to a take-over bid by a more efficient company, or to liquidation.

STATE-OWNED ENTERPRISES

As heir to Hitler's State monopolies, Germany's Federal Government, States, and municipalities inherited shares in basic industries, as set out in Table I below.

TABLE I.

Product	Per cent of national production
Coal and coke	35·3
Iron ore	55
Lignite and jet	75
Lead and zinc	43·8
Crude iron and steel	22
Aluminium	70
Crude petroleum	25·4
Electricity	61·5
Electricity distribution	96
Gas	91

The Federal government alone has an interest in over 400 companies, sole control over 220, and employs over 200,000 workers.

Germany's first aim has been to transfer control of as many enterprises as possible back to private ownership, because after their experience of the concentration of economic and political power under Hitler's dictatorship, Germans want to diffuse power as widely as possible in a property-owning democracy. While efforts are being made to denationalise (or as they call it, to "reprivatise") as many enterprises as possible—already Preussag, which employs 22,000 in mining and producing coal, petrol and metals, has been sold back to the public, and Volkswagen is to follow shortly—a huge sector must remain state-owned. As the Minister for State Owned Industries said to me: "Who, in 1961, wants to buy a coal mine?"

In Germany, each State-owned enterprise competes for capital in the market. Their borrowing terms depend on the market's estimate of their earning capacity. Therefore, the prices charged for their output must be those of the market. It follows that Germany's State-owned enterprises are run in as business-like a manner as private enterprises. The Federal Government just happens to be a shareholder. But, of course, if a company's record is persistently poor, the Government, like any other shareholder, puts in new directors.

Since German State-owned enterprises work under competitive conditions, the possibility of their transfer back to private ownership has little effect on their long-term planning, and since no party stands for nationalisation, private firms also can plan ahead, free from uncertainties.

Compare German "State-ownership" with British "nationalisation." The products of British nationalised industries have hitherto been sold at artificially low prices, lest market prices stir up political hornets' nests. Investment, therefore, has had to be financed out of gilt-edged loans at low interest rates. Even so, they have usually failed to cover costs at the prices charged, so that investment yield has been about 5 per cent, compared with 15 to 20 per cent in private enterprise. The Government seems now to realise that, when low prices compel them to finance investment by issuing more Government stock every year, the door against inflation cannot be closed. Where, as in Germany, market prices are charged, the comparative costs of coal, gas, electricity, and oil, for example, sort out themselves. In the United Kingdom, charges to private consumers, kept below prices to industry, have stimulated wasteful private consumption, raised costs to industry, and increased unnecessarily the huge investments needed less in order to raise efficiency than to cope with artificially swollen demand.

TABLE II:—*Domestic and Industrial Prices in the United Kingdom and the European Coal and Steel Community**

	United Kingdom			ECSC		
	Domestic	Industrial	Ratio D/I	Domestic	Industrial	Ratio D/I
(*a*) Gas	19·9	11·4	1·75	27·8	8·9	3·13
(*b*) Electricity	1·6	1·3	1·23	3·6	1·2	3·00
(*c*) Transport	2·0	2·7	0·74	2·5	2·3	1·09

(*a*) Prices per therm charged by the East Midlands Gas Board and in the Ruhr.
(*b*) Pence per kWh
(*c*) Pence per passenger-mile and pence per ton-mile for an average of iron ore, steel scrap, and steel charges.

NATIONAL AND SECTIONAL INTERESTS

Does all this mean that Germans consider that there is no such thing as the "national interest" over-riding the "selfish interests" of particular groups? The answer must be sought in the writings of the German economist, Mr. Walter Eucken, who preached the economic doctrines that Professor Erhard practises. Mr. Eucken said that the national interest is best upheld in a society in which there is full scope and reward for the individual initiative of all citizens, in which as many as possible, consistently with the avoidance of inflation, are kept employed, and in which no one is allowed to fall below a minimum level of wellbeing. This level, he added, must be defined in terms of what is economically possible, consistent with, first, the avoidance of disincentives to work and save, and secondly, the expansion of the economy; so that all may share in a growing cake rather than dispute the redistribution of the existing cake. The government's role is to enforce competition and to maintain a favourable economic climate. No economic system is perfect. There will always be groups struggling to assert special interests, but Mr. Eucken pointed out that, in Hitler's totalitarian Germany, more groups were able to assert themselves than in a free-enterprise society, because they acquired vested monopoly interests built-in to the structure. The wider the spread of State control, the greater the multiplicity of these vested interests, whereas in a free-enterprise society, the government can acquire without nationalisation (which creates monopoly interests) all powers needed to make national policy prevail over the "commanding heights" of the economy.

In the United Kingdom since the "public interest," as defined by electoral considerations, has hitherto largely prevailed over business principles in managing nationalised industries, it seems inevitable that a substantial proportion of the £6,827 million invested in them has been allocated uneconomically and used wastefully, and that this tendency has distorted our economy and slowed its growth. It is one of the outstanding strengths of Germany's economy that it does not labour under such distortions.

* Sir Robert Shone and H. R. Fisher, "Industrial Production and Steel Consumption," *Journal of the Royal Statistical Society*, Series A (General), Vol. 121, Part 3, 1958, p. 293.

Fusion Consolidates

THERMONUCLEAR research continues on an extensive scale, but since the release of information concerning Zeta and the 1958 Geneva conference, when over a 100 papers on the subject were presented, it has seldom made headline news. Perhaps the experience with Zeta has caused the various bodies involved to be more reticent. A conference on "Plasma Physics and Controlled Nuclear Fusion Research," organised by the International Atomic Energy Agency and to be held at Salzburg next September, may reveal the results of more recent experimental work. The state of the art was reviewed in the forty-seventh Thomas Hawksley Lecture delivered by Professor P. M. S. Blackett at the Institution of Mechanical Engineers last week. The lecturer refreshed the memory of his audience on the collosal energy potential of thermonuclear

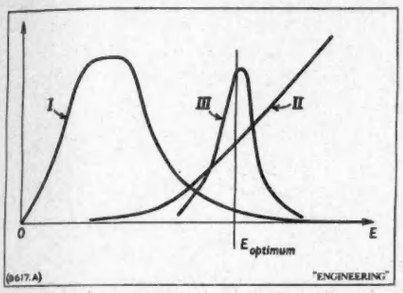


Fig. 1 Energy distribution of ions producing fusion reactions.

reactions, but elaborated on the problems to be solved before this prospective source of power can become a practical proposition.

Basic Reactions

There appear to be three main basic reactions between particles that are of importance in thermonuclear work, although more may be included later. The first two involve the collision of two energetic deuterons (D), and the following reactions occur in almost equal proportion.

$$D + D \rightarrow He^3 + n + 3{\cdot}3\ MeV \quad .. \quad (1)$$
$$\rightarrow T^3 + p + 4{\cdot}0\ MeV \quad .. \quad (2)$$

The third reaction involves a triton (T) and a deuteron.

$$T + D \rightarrow He^4 + n + 17{\cdot}6\ MeV \quad (3)$$

In this case not only is the kinetic energy released larger but the reaction occurs more frequently. Also, the cross-section for the triton-deuteron reaction is about 100 times higher than for the first two reactions. But in all three cases the effective saturation is reached at about 10^9 °K. Although tritium does not exist in nature, since it has a half life of only 12 years, it can be produced by a number of methods, and once a successful fusion power reactor is set up it will be possible to breed tritium as a byproduct.

High Initiating Temperatures

In spite of the large ratio of energy produced to energy of the incident particles in a deuteron-triton reaction, the direct acceleration of the particles, and their impact on a cold target containing the same particles, does not provide a suitable opening for the useful production of fusion power. The incident particles lose energy so rapidly to the electrons that only a small number produce a nuclear reaction before they are slowed down. However, heating the target to such a high temperature that the temperature of the electrons and the incident beam are the same, makes the incident beam redundant, since the deuteron and triton particles in the target have enough thermal energy to make the occasional fusion reaction with each other. It has been shown by R. F. Post ("Controlled Fusion Research—Applications of Physics of High Temperature Plasmas") that to produce more fusion power than is lost directly by the plasma in radiation requires a temperature of nearly 4×10^7 °K for the deuteron-triton reaction, and 4×10^8 °K for two deuterons.

Two Methods of Heating

To achieve these high temperatures two methods have so far been used: a short transient high temperature and pressure produced dynamically in the form of an explosion, for example in the hydrogen bomb; or a similar but more controlled effect by heating and containing the plasma electromagnetically. A version of the first approach is the use of a chemical explosion, but an experiment carried out in the Soviet Union along these lines produced only a few neutrons and completely destroyed the equipment.

Electromagnetic Heating

A more promising method of heating a deuterium and tritium plasma to a high enough temperature and pressure to produce fusion, is to accelerate a hot plasma to very high velocities by electromagnetic means and to convert the

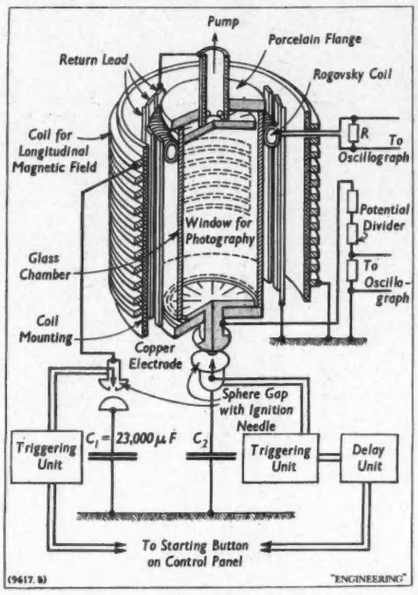


Fig. 2 Diagram of a Soviet device for high-current linear pinched discharges with an axial magnetic field.

kinetic energy of the plasma into heat energy by letting the different parts of the plasma collide with each other. This result can be achieved by using the inward radial acceleration of a linear or toroidal self-pinched discharge. Although a favourable balance in energy seems possible, the large amount of energy evolved during each compression brings the process into the explosion class. Thus static or semi-static methods are sought in preference to the transient dynamic methods. It is possible to confine a plasma for a considerable time by means of a magnetic field owing to the high electrical conductivity of a plasma: the effect of eddy currents produced in it by any change of magnetic field is to prevent any relative motion of a volume of plasma transverse to the field.

Forms of Containment

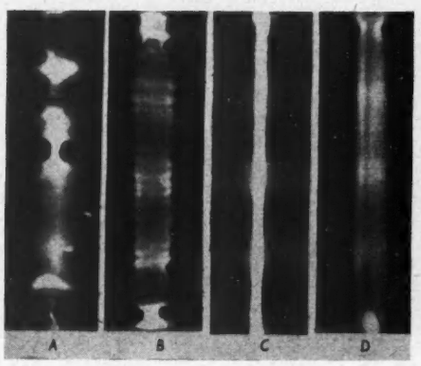
The two main forms of magnetic containment are the self pinch, where the plasma is contained by the magnetic field due to an electric current passing through it; and the magnetic bottle, where the containing field is produced externally. The external magnetic field produces an electromagnetic "pressure" on the plasma, thereby containing it, and if the field is made to increase rapidly the plasma will be compressed and heated.

Energy Distribution

In a moderately hot plasma in temperature equilibrium it is the deuterium and tritium ions which comprise the high energy tail of the Maxwell energy distribution diagram; these ions are the most effective in producing fusion reactions by their mutual collision. This effect is shown in Fig. 1 where the broad peak (I) represents the normal energy distribution, the sloping curve (II) the rise of the fusion rate with energy, and the narrow peak (III) the energy of the ions which contribute most to the fusion reaction.

Heating Mechanisms

A plasma can be heated in several ways, such as: by shock heating, by adiabatic compression,



(*a*) Inward collapsing pinch after 13 microseconds. (*b*) Pinch at minimum diameter (less than 0·1 of tube) after 15 microseconds. (*c*) Expanding pinch showing Rayleigh-Taylor dynamic instabilities due to inward acceleration of the interface between the magnetic field and the plasma; taken after 20 microseconds. (*d*) Electromagnetic instabilities particularly marked near the centre, taken after 25 microseconds.

Fig. 3 Formation and break up of linear pinch in argon.

by Joule heating, by resonant absorption of high-frequency radiation, or by injection of already energetic ions. In spite of much theoretical and experimental work all have run into problems of two distinct but closely related kinds.

Instability and Energy Loss

It is difficult to keep the plasma confined stably for long enough to obtain appreciable fusion, and the plasma loses energy faster than expected so that the anticipated temperatures are not reached. The ratio of the plasma pressure to the external magnetic pressure is important. If this ratio is approximately unity the plasma interacts and distorts the magnetic field, making a theoretical analysis impossible. But there is a possibility of producing electric power directly from fusion energy without an intermediate thermal cycle.

Devices Inevitably Large

A power producing fusion device using magnetic containment must necessarily be large, since the fusion power produced in a given volume must be greater than the electric power required to maintain the containing magnetic field; and also the electric power used in a solenoid of given shape to produce a given magnetic field is proportional to its linear dimension while the fusion power is proportional to the volume.

Dynamic Self-Pinched Plasmas

The self-pinch effect of a high current in a cylindrical gaseous discharge results from the mutual attraction of two parallel current elements, causing the gas to snow-plough. An

example of this is shown in Fig. 2 where a high potential condenser bank discharging through a tube containing deuterium is used to give a very rapid rise of current with time. However to obtain sufficiently high temperatures (10^9 °K) the machine would be enormous, and it is thus ruled out by practical limitations.

Semi-Static Self-Pinched Plasma

When attempts are made to confine a hot plasma for a period of milliseconds or more, a toroidal discharge tube will be convenient since the end effects due to the electrodes of a linear pinch arrangement are eliminated. Fig. 3 shows the break-up through instabilities of a linear pinch in argon. The gas is at a sufficiently high pressure to reduce the mean free path of an ion before collision to much less than the diameter of the discharge, so that the plasma can be treated as though it behaves approximately like a magneto-hydrodynamic fluid. But the plasma motion observed shows that much experimental study is necessary before a complete understanding is possible.

Sources of Energy Loss

In most experimental devices an emission of about a million or more neutrons is observed every pulse, indicating that the deuteron-deuteron reaction has occurred; but it has been concluded after much study that a small fraction of deuterium ions are accelerated to several keV by electric fields produced in the discharge by some type of instability (Fig. 3d). These are of electromagnetic origin and lead to rapid changes of self-induction and to big axial magnetic fields. It is also concluded that these instabilities, oscillations, and general collective motions are probably the main origin of the more rapid energy loss which prevented the plasma from attaining its expected high temperatures.

Magnetic Compression Devices

A magnetic-bottle effect is produced by having a central cylindrical section with a uniform magnetic field, and end mirrors to produce a greater field. If a plasma is produced in a magnetic bottle and the field is suddenly increased, the plasma will be compressed to a thin cylinder on the axis; it then bounces, as in the dynamic self-pinched discharge, and expands a little. The magnetic pump heats the plasma and produces an adiabatic temperature rise and particle concentration. Unfortunately the external energy required is even greater than that required to produce a self-pinched plasma.

Approaching a True Thermonuclear Reaction

Fig. 5 shows a three stage magnetic compression device at the Livermore Laboratories of the University of California. The plasma is formed by magnetic compression in the right-hand tube and transferred to a second chamber where it is further compressed to reach an ionic temperature of 3×10^9 °K with a much lower electron temperature. The final plasma seemed effectively and stably contained for nearly one millisecond, and it is this device that appears to have successfully yielded true thermonuclear reactions, unaccompanied by a great number of reactions due to directly accelerated ions. However, it is still liable to certain forms of instability, but stability remained about a thousand times longer than the simple magneto-hydrodynamic equations suggested. This is a definite step forward.

Ionic Injection

Many attempts have been made to build up a hot plasma slowly in a static magnetic bottle by injecting high-energy dueteron atoms from an external accelerator. The plasma grows with time but is always at the ionic temperature corresponding to the injected particle energy.

The Soviet " Ogra " (Fig. 4) and the United States DCX are examples of this type of machine. The ions are kept in the magnetic bottle and with their high temperature and concentration and a reasonably long containment time, an appreciable yield of fusion reactions results. Again it would be advantageous to build a large machine to study the reactions, but practical and economic considerations are limiting factors, and it is felt that more reward can come from the study of the basic fundamentals in smaller machines until a deeper understanding is gained. This reason was given for abandoning the Intermediate Current Stability Experiment (ICSE) (Atomic Review, 7 Oct. '60).

Crystal Gazing

The task for the future is to construct a device that will give an adequate number of neutrons arising from completely thermalised deuterium ions and to use them to make a sensitive diagnosis of the physical conditions of temperature and particle concentration in the plasma. It is necessary for the plasma to be free of neutrons from directly accelerated ions. When the number of neutrons arising in a single discharge pulse reaches a value over 10^{12}, then it may be considered that all the neutrons are produced from thermalised ions. Further possible steps springing from these considerations are the construction of an improved device which will act as a convenient source of neutrons at least equal in efficiency to the best obtainable by direct acceleration of dueteron and triton ions in an electrostatic machine. An efficiency of 10^{-2} might be aimed at initially.

Another factor is optimisation of equipment size, since large equipment slows the work down and equipment that is too small presents scaling-up problems. Undoubtably the field is still wide open for ideas and much experimental study must follow.

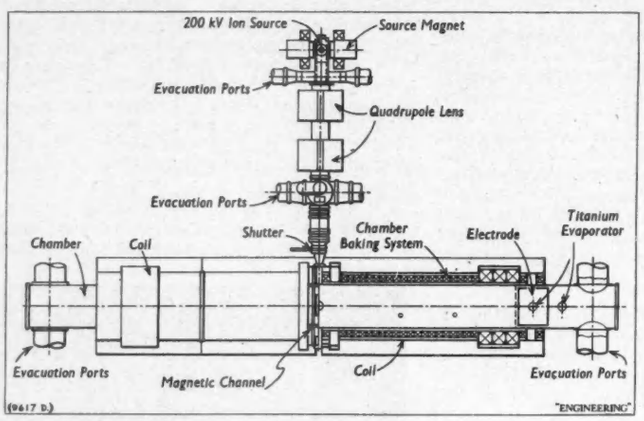


Fig. 4 (left) Diagram of the Soviet injection machine " Ogra."

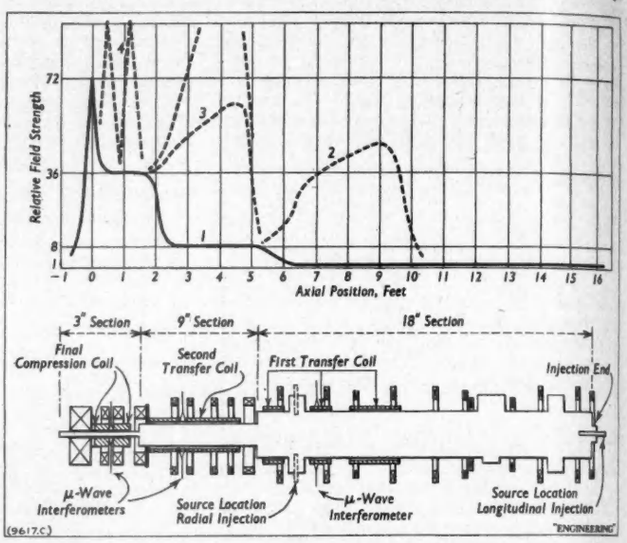


Fig. 5 (right) Three-stage magnetic compression device used at the University of California.

Notes and News

Changes in the UKAEA

Changes in the organisation of the United Kingdom Atomic Energy Authority will take effect on 1 April. In their report of July, 1959, on the Industrial Group of the Atomic Energy Authority, the Select Committee recommended that certain aspects of the Authority's organisation should be reviewed after a reasonable period. This review has now taken place and the Authority have decided upon certain changes designed to improve coordination and efficiency. A Deputy Chairman will be appointed with primary responsibility for scientific and technical coordination throughout the Authority. Sir William Penney will fill this post from 1 April.

The work of designing and developing nuclear reactors will be concentrated, to the greatest possible extent, in one Group of the Authority, and the major development facilities required for this purpose will be under its control. The structure of the Development and Engineering Group will be modified for this purpose and will be renamed the Reactor Group. It will be responsible for the design and development of reactors; and for relations in this field with industry at home and with overseas countries. The Winfrith Research Establishment, which has responsibilities in the same field, will be transferred from Research Group to Reactor Group.

New Engineering Group

The Development and Engineering Group's existing responsibilities for the design and construction of plant, works and buildings will be transferred to a new Engineering Group, which will also take over from the Production Group its responsibilities for the design and inspection of fuel elements for production purposes. Apart from the transfer of the Winfrith Research Establishment, the structure and responsibilities of the Research Group remain unchanged. The Weapons Group is also unaffected by the new arrangements. Sir William Cook, at present Member for Development and Engineering, will in future be known as Member for Reactors.

Sir Leonard Owen's responsibilities will now extend over the Production and Engineering Groups with the title of Member for Production and Engineering.

Further New Appointments

The following appointments will take effect from 1 April:

Director of the Research Group: Dr. F. A. Vick, O.B.E. (who will continue as Director of AERE, Harwell). Managing director, Reactor Group: Mr. R. V. Moore, G.C. Managing director, Engineering Group: Mr. J. B. W. Cunningham. Managing director, Production Group: Mr. J. C. C. Stewart, C.B.E.

Companies

Growing Research Costs of Photographic Firms

AT HOME, in industry and in the office, photography is being put to increasing use. The result, for a firm like ILFORD Limited, who produce photographic materials and equipment, is rising turnover. In 1960 this reached record levels, with a growing research and development expenditure.

Overseas Ilford are a very active company, raising their exports last year substantially and entering into a technical agreement in Spain. With the photographic company S.E. DE PRODUCTOS PHOTOGRAFICOS S.A. VALCA, Ilford have agreed to the sale of technical information and now hold a 25 per cent interest in the Spanish company.

A successful start has been made with a subsidiary in Germany and the company is considering what further European extensions should be undertaken in the light of the divergent economic groupings. Further afield, in Australia, the Ilford subsidiary has been extending its Melbourne manufacturing facilities and is considering wider development of its activities in Australia.

Press Button Focus

The most recent Ilford introduction was at the "relatively inexpensive" end of the camera range. A new model about to be launched falls higher in the price list (under £30) but has a photoelectric cell exposure meter and uses a press button focus control, ideal for those who are attracted by completely automatic camera adjustment.

Manufacture of Ilford products has been concentrated on factories at Ilford, Brentwood, Mobberley and Basildon. The heavier burden of research being undertaken by the company has led to reorganisation of the laboratories and an extension is being built to the Ramsden laboratory at Brentwood.

The home sales organisation is being given a new organisation, on a regional basis. An extensive reshaping of the distribution system should lead to faster and better service. Last summer some shortages were encountered, due in the main to bottlenecks in production. These have now mostly been overcome.

One of the company's activities shows dramatically the lively interest in amateur photography supporting the firm's prosperity. This is the practice of keeping open house at the main London showrooms on the first Thursday evening of every month for all those who wish to turn up and use the equipment provided. In one evening there were 2,500 visitors.

Selling Back the Steel Securities

Twelve securities—all debenture stocks and preference shares—in seven major steel companies were this week being sold back to the general investing public. The companies concerned are a roll call of the most famous names in iron and steel with one name RICHARD THOMAS AND BALDWIN missing.

The seven concerns are: COLVILLES, the UNITED STEEL COMPANIES, JOHN SUMMERS, DORMAN LONG, STEEL COMPANY OF WALES, CONSETT IRON and STEWARTS AND LLOYDS.

Completion of the sale by the IRON AND STEEL HOLDING AND REALISATION AGENCY, which was set up by the Government to sell the holdings brought about by the nationalisation of steel, will remove all the securities in Colvilles, the United Steel Companies, Consett Iron and Dorman Long from the hands of the agency.

Nominal value of the securities amounts to £105 million, but substantial discounts in every case bring the cash value down to £85·3 million. The yields have been calculated at about $6\frac{5}{8}$ per cent on debentures, $6\frac{3}{4}$ per cent on loan stocks and $7\frac{1}{8}$ on preference shares.

A Just Offer

The exception is the still nationally owned RICHARD THOMAS AND BALDWIN company. With the major development of the Spencer steelworks at Llanwern, in South Wales, and additional schemes in the Ebbw Vale and other works of the company, ISHRA has not yet felt able to offer the company back to the public. A statement made four months ago said that the sale would not take place until the development projects were closer to maturity. The productive capacity and the profits of RTB are so closely tied up with the new capital investment, which last year was running at £37 million and this year will be even greater, that it may be two or more years before there exists a fair body of information on which to arrive at a just offer to be put before investors.

The remaining companies whose equity capital is still in the hands of ISHRA are all small.

Shipyard Doldrums but Diesels Going Ahead

BURMEISTER AND WAIN, the Copenhagen, Denmark, shipbuilding and marine engineering company, are meeting the same difficulties in finding new orders for ships as their British counterparts.

The company's report for 1960 states that only one ship was ordered during the year by a Danish owner, two others, dry cargo vessels, were ordered for the Soviet Union. Contracts were obtained for three mid-body sections for ships being reconditioned by a United States shipyard. Developments in tanker operations have overtaken the ordered tonnage not yet begun in the yards. Negotiations are in hand on enlarging the size of some of the tankers when they come to be built. Burmeister and Wain will also benefit from the growing practice of powering even the larger tankers with diesel engines.

A new diesel engine with considerably greater output was announced more than a year ago. A unit of the new design has now been in service in the EAST ASIATIC Company's tanker Java for a year. A ten cylinder engine of this type, developing 21,000 bhp in daily service and 25,000 bhp on the testbed, has been delivered to a Norwegian shipowner. This is so far the largest marine engine built by B. and W.

Some indication of the demand for engines of the new design is given by the order list, which has now grown to 26, representing a total output of 475,000 bhp. The company looks forward to motor tankers of 50,000 tons and more going into service. The total order book of B. and W. and their licensees for diesel engines represented 3·3 million bhp at the close of the year, which compares with 2·8 million bhp twelve months earlier.

From the B. and W. shipyard eight ships, with a total deadweight of 85,900 tons were delivered during the year. The engine works output for the year was equal to 220,000 bhp, against 300,000 bhp in 1959. Employment was increasing in the shipyards but declining in the engine works.

Gold Plated Computer for Pension Sums

EMIDEC 2400 computers, capable of simultaneously absorbing fresh information, processing data already fed in, and printing previously compiled results, have been ordered by the Ministry of Pensions and National Insurance. They are to be used in calculations for the graduated pensions scheme.

The Royal Army Ordnance Corps are also to use computers for the control of motor transport spares stocks.

The EMIDEC—whose wiring is shown being tested at the Hayes,

Middlesex, works of EMI ELECTRONICS—have gold plated plugs and sockets, which assists reliability. They can perform one and a half million calculations a minute.

USA Transmission Market Expected to Improve

The net income of the WESTINGHOUSE ELECTRIC CORPORATION for 1960 after payment of tax was $79,057,000 (£28,234,000), which works out at $2·22 on each common share. This was the same level of earnings on each common share as in the previous year.

Westinghouse net sales in 1960 were almost $2,000,000,000, about $50 million more than in 1959. Provision for federal income tax and foreign taxes was down from almost $77 million in 1959 to just under $66 million. There are 35 million common shares in Westinghouse.

Mr. Mark W. Cresap, Jr., the Westinghouse president, reported in his summary of the year's operations that new business booked in 1960 was at much the same rate as in 1959. 1961 began with "comfortable backlogs." A tighter squeeze on earnings was being applied by inflation in materials and labour costs at the same time that there was a general softening of prices. This pressure on earnings is expected to increase throughout the first half of this year.

A gleam of hope for the United States manufacturer, and the exporter to the American market, is given by the Westinghouse president who suggests that price levels of many industrial products have declined to a point where some improvement can be expected in the near future. There are also indications that the market for transmission and distribution equipment will be more active this year than last.

Westinghouse capital expenditure rose by 50 per cent during the year, from $45 million to $68 million.

In the semi-conductor department, a new facility has been completed at Youngwood, Pennsylvania, for the development and processing of semiconductor materials, including new forms of silicon and germanium. The Youngwood works was the first of its kind in the United States, five years ago. The new plant gives a threefold increase in capacity.

The Diverse Growth of Harper Engineering

From makers of industrial saws and flexible shaft equipment to a large team of consultant engineers, the new companies added to the HARPER ENGINEERING & ELECTRONICS group during the past year considerably expand that organisation's diversification.

Returning a profit (after tax) of £843,194, the group has reached earnings that are a substantial improvement in relation to the issued share capital.

The new companies in Harper Engineering include SAMUEL PLATT Limited, the Wednesbury heavy engineering concern well known for the wide range of their special purpose heavy machinery.

Another new subsidiary is the MORRISFLEX GROUP of Coventry who produce, among other things, flexible shaft equipment and automatic polishing machinery made under a United States licence agreement.

Export Drive

Another new subsidiary, J. B. & S. LEES of West Bromwich, produce precision rolled, hardened and tempered steel strip. In the year before becoming part of the Harper group £300,000 was spent by this company on modernisation and new equipment.

The consultant engineers, engaged in research design and development projects, some of them connected with nuclear engineering, are the 250 strong SPEMBLY Limited.

Indirect exports by the group through home market customers are already considerable but there is now to be a drive to expand the proportion of direct exports, particularly to the Eastern European countries and Russia and to Western Europe.

Boiler Consortium for Power Stations

A joint company, FOSTER WHEELER JOHN BROWN LAND BOILERS CONSORTIUM—has been formed by Foster Wheeler Limited and John Brown Land Boilers. The new firm will carry out power station boiler construction and installation in the United Kingdom and Eire.

AEI-Hotpoint Supermatic

In the highly competitive field of washing machines the choice of a suitable candidate for Product Profile was a narrow one. Marketing aspects are critical as the story of the Supermatic shows.

THE Hotpoint Supermatic is the fulfilment of the planner's dream. Here is a case where vigorous market study in the early stages resulted in virtual elimination of the guesswork factor. Sales during the first year have already proved the wisdom of intelligent planning.

With accusations often levelled at the planners, rightly or wrongly blaming them for the various present day muddles in which we find ourselves, it is reassuring to meet a product whose success is so entirely dependent upon a far-thinking and comprehensive planning organisation. The success of the Supermatic in terms of numbers sold almost exactly matches Hotpoint's reasoned expectations, and discrepancy is all on the good side. The inception and creation of the Supermatic were the result of perhaps the most thorough market investigation ever performed in Britain for a " consumer durable " product.

The Supermatic is a semi-automatic " twin-tub " machine which means that the wash and spin-dry sections are separate, and transferring the clothes from one to the other has to be performed by the operator. This contrasts with the fully automatic type generally associated with launderettes, where the wash and spin-dry sections are combined and the machine performs a complete cycle of operation without attention. Marketing considerations are quite different for the two types, the semi-automatic being favoured in this country for home use.

A successful washing machine, or any domestic appliance for that matter, means big business for the manufacturer. The introduction of a new domestic appliance is a major undertaking both in time and in financial commitment, particularly the latter. To ensure that the expenditure becomes a successful investment the new product must sell at the planned volume, and this can be only obtained by having a high degree of consumer acceptability. The selling volume can never be absolutely guaranteed beforehand, but there are ways of making a pretty accurate forecast.

The success of the initial market research depends firstly on the finance allocated to the department responsible. Up to a point the probability of accuracy and hence the value of the forecast is proportional to the amount of money the firm are prepared to stake. But that is not all. The success of the whole operation depends finally on good management. For unless the market research resources are properly directed the risk of failure is high.

AEI-Hotpoint Limited of Grosvenor Place, London, who market the Supermatic, has established a clearly defined policy for the development and manufacture of all its products. They include washing machines, refrigerators, vacuum cleaners, electric irons and kettles, and water and space heaters.

The company was originally known as the Hotpoint Electric Appliance Company Limited, and was formed in 1920 as a subsidiary of BTH, then itself a subsidiary of the American General Electric Company. For many years Hotpoint in Britain was merely a selling company, dealing first in products imported from America, and later in washing machines, vacuum cleaners and smaller appliances made by BTH for sale under the Hotpoint name. In 1929 BTH became one of the original members of the AEI group.

After the Second World War steps were taken to expand gradually the AEI group's domestic appliance side of the business. Two other companies, International Refrigerator Company Limited (Coldrator) and Premier Electric Heaters Limited, were acquired and placed under Hotpoint's management. About four years ago the expansion programme was accelerated. A new marketing department was constituted comprising specialists in market development, product planning, market research and appearance design, and assumed responsibility for initiating new projects.

MARKET INVESTIGATION

The company's basic objectives in the design of each new product centre around acceptability to the customer, and they are nowhere more evident than in the Supermatic. The principal ones are optimum performance based on a study of the fundamentals of the task to be performed, freedom from any disadvantage in use, reasonable durability, and safety in operation. Design is based initially and primarily on extensive consumer research in order to give the design department a clear brief as to what is expected. Product research follows on, allied with continuous investigation of new materials and techniques. Relevant British Standards are taken as the minimum requirements.

Technical Particulars

Type	Twin-tub, semi-automatic
Clothes load	5/6 lb
Washing action	Agitator, with filter clean device
Rinsing and drying	Spin tub with automatic braking, 4 minutes drying time
Overall size	30 in long by 18 in wide by 34 in high
Net weight	150 lb
Mounting	Four castors
Heater capacity	2·3 kW
Controls	Automatic preset wash time and temperature
Colour choice	White or cream enamel

Preliminary work on the Supermatic started about four years ago, three years in advance of the target date for launching the first production models. The first step was to examine closely the existing market for washing machines. The market was divided into sectors corresponding with the different kinds of machine available, for example fully automatic, twin tub and single tub with hand or power wringer.

Hotpoint then assessed each sector in turn with regard to the percentage of the total market held by each type of machine, paying particular attention to future trends, i.e. whether the demand was rising, falling or holding steady. A reasonable certainty had to exist that when the newcomer was launched the demand would be large enough for it, and be sufficiently profitable for some years to support a big business entry.

Once the type of machine had been settled, it was time to move on to the second phase of market investigation. Field investigators called on 2,000 to 3,000 housewives to ascertain their views on laundry habits, washing machines in general and twin-tub machines in particular. How did they like the performance, controls and appearance of the machine they owned, or what facilities would they like to have if they owned one? Good management is particularly important at this stage, and the field investigators, were armed with a questionnaire.

The result of the investigators' findings enabled Hotpoint to build up a very clear picture of the average housewife's requirements, in particular the chief shortcomings of existing machines. Convenient placing of the controls to eliminate

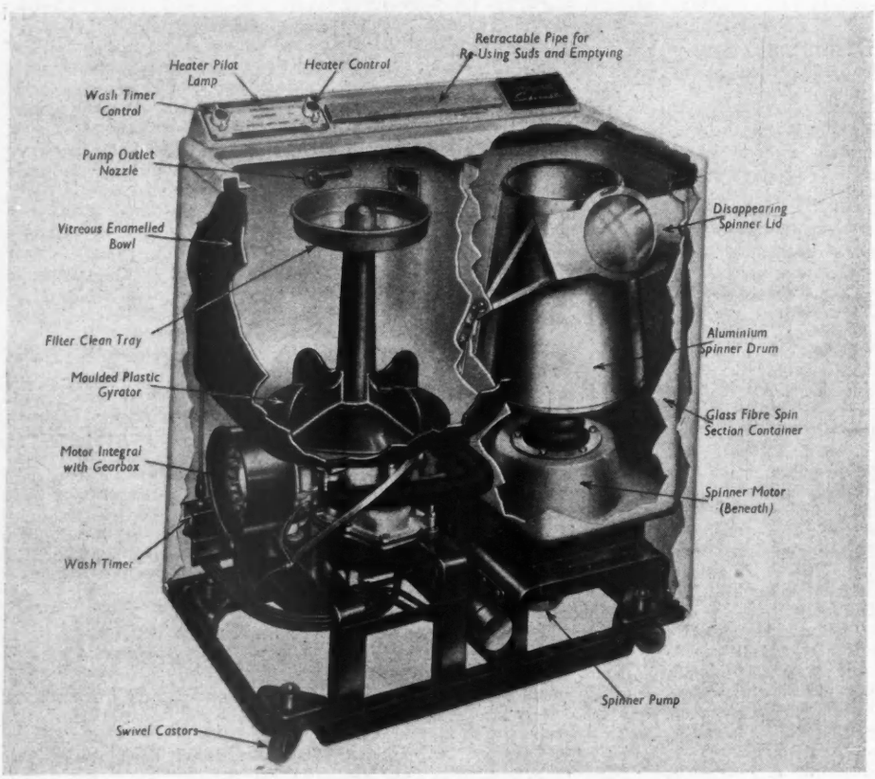


Fig. 1 Cutaway showing principal features.

Fig. 2 With a critical study of customer requirements and market trends, success can be practically guaranteed.

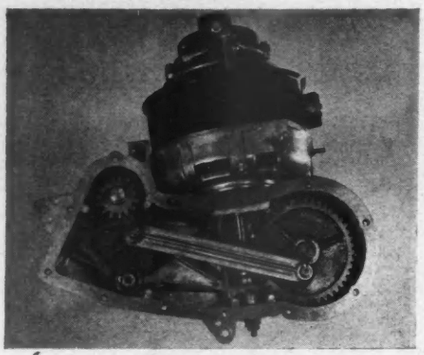
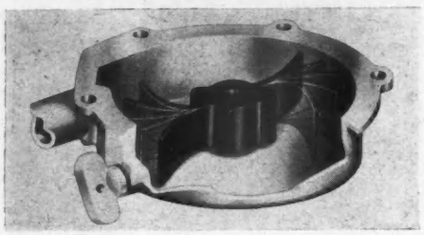


Fig. 3 (above) Gearbox, showing gyrator drive.

Fig. 4 (below) Spin-dry pump.



stooping to operate them might seem obvious, but it was one of many factors, the importance of which had to be learnt if the new machine was going to fulfil its expectations. Above all, Hotpoint realised that it was what the customer wanted that counted, not necessarily what the trade or the industry consider desirable. And whatever mechanical ingenuity was built into the design, it would be of no use unless it conferred some positive social benefit.

PRODUCT OBJECTIVE

Once the design department had been given the results of the consumer research enquiries they were able to make their contribution to an important document known as the "product objective." This specified the wash, rinse and spinning performance required; the maximum overall dimensions; the type of wash, heater and spin controls; the maximum acceptable cost and the target date for starting manufacture. Hotpoint also now decided that the Supermatic would be manufactured at their Llandudno factory in North Wales, where ample space existed for the necessary extension, and also scope for increasing the labour force. New machine tools were placed on order, the design of which progressed hand-in-hand with the detail design work on the various parts of the Supermatic.

From production drawings a limited number of hand-made prototype machines was built, both to check performance and to assist the marketing department in the planning of their advertising strategy, brochures, and service and training manuals. All the time continuing market investigation was bringing in fresh information.

As complete sets of components off production tooling became available, pre-production machines were built. In addition to normal factory testing, some models were entrusted to certain employees to test the newcomer in their own homes. It was also necessary to establish that mass produced production components performed at least as well as the original hand-made samples. However, even laboratory and home testing of prototypes over a period is not entirely conclusive.

The Supermatic was confined to Scotland at first. Localising the launching area had many advantages, apart from the obvious one of limiting teething troubles. It allowed the flow of production to build up more gradually; it gave Hotpoint the opportunity of calling on each consumer to obtain her reactions; it acted as a check on the accuracy of the production forecast in time to make last-minute adjustments to the programme; and it also made a useful test-advertising ground.

TECHNICAL FEATURES

"The Supermatic washes extra clean—spins extra dry." Thus does Hotpoint's publicity describe a machine which is full of attractive design features to the engineer, only a few of which can be mentioned here.

The wash section of the machine occupies the left-hand portion of the cabinet, and contains a vertical gyrator which performs an agitating action by rotating 214 degrees in either direction at a speed of 65 cycles per minute. These figures are critical to the effectiveness of the agitating movement, which is patented and is firmly believed to give a "no tangle" and more

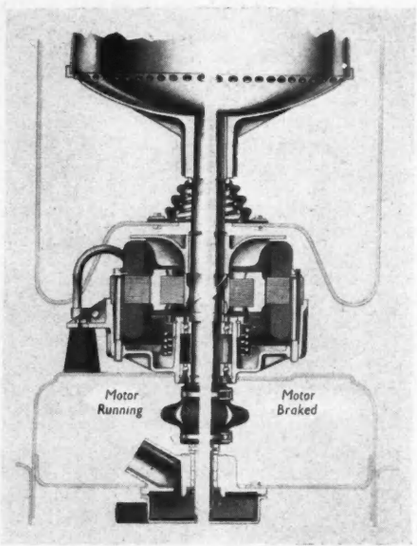


Fig. 5 Section through spin-dry mechanism.

thorough washing action than is possible with a rotary action using a tumbler or high speed impeller. On the debit side, the gyrator demands a certain degree of complication in its driving mechanism, as Fig. 3 reveals, and it puts Hotpoint at a slight cost disadvantage.

The gearbox has been made more compact than in the earlier models by reducing the size of the working parts. The self-cooling driving motor is integral with the gearbox, the rotor being keyed directly to the worm shaft.

Another intriguing feature is the one described as "filter clean." As clothes are worn, particles of fluff—"lint"—become rubbed free of the material, but tend to remain in contact with it until the garment is washed. In a washing machine the lint floats in the water until the clothes are taken out, when much of it will be picked up again. The effect is to slightly discolour them. In the Supermatic, Hotpoint have taken special precautions to remove the lint by arranging the emptying pump to provide continuous circulation during washing, and deliver the water back into the top of the wash section through a fine mesh filter tray resting on the gyrator. The shape of the discharge in combination with the movement of the gyrator causes the lint to coagulate on the filter, where it can be seen and readily removed.

The filter clean facility introduced some special incidental design problems. The conventional type of pump protection filter at the bottom of the wash chamber would discourage the lint from passing into the pump, and thus defeat its object. So a new filter was designed, consisting of a combination of weirs. Leakage of the pump seal due to the presence of lint was another problem, solved by a new seal with double lips.

The spin dry section of the Supermatic represents Hotpoint's first entry into this field, previous models having either hand or power wringers. The opportunity was taken to provide a spinner giving the maximum water extraction, with a speed of 2,850 rpm, fully loaded. A series of tests decided the shape of the spinner drum, and holes for water removal were confined to the bottom as at such a high speed perforated sides would mark the clothes.

Like the gyrator drive, the spinner has an integral motor with the rotor attached to the spinner shaft. The stator is mounted rigidly in a frame and three-point resilient mountings allow for unbalance. A novel form of braking was devised and patented. The rotor runs on a helical spline on the spinner shaft and is so arranged that when current is passed to the stator the rotor rises to the upper position, lifting the brake pads off the brake table. When the spin lid is lifted, the main windings are shorted and gravity plus the transient back emf cause the rotor to drop and apply the brake.

The spin drier water pump is shown in Fig. 4. It has a rubber impeller with the blades specially designed to allow the pump to operate at full capacity at approximately 30 per cent of full motor speed. As the speed increases the effective diameter of the blades decreases so that the load on the motor and pumping rate remain approximately constant. Pumping at low spinner speeds is essential to prevent suds lock friction build-up in the spinner.

Many products previously treated in Product Profile have been affected by the current tendency to introduce the maximum degree of automation. Provision of full automatic control for washing machines is unlikely to become generally accepted in British households in the near future, despite its popularity in the USA. The chief factor is high cost, £100 and above, associated with different household conditions over here. For instance the automatic machine requires large quantities of hot water, is often non-portable and some models require permanent plumbing connections. However, the Supermatic is also becoming popular overseas, where it is sold under the name AEI-Gala Limited, a sister selling company.

The cost of the Supermatic, including purchase tax, is 89 guineas (£93 9*s*), not much below that of the lowest priced automatic. But Hotpoint know that they have a large customer potential who are prepared to pay for quality provided that they are made aware of it. Accordingly they employ high powered advertising tactics using all the available media, including television which definitely favours the product with demonstrable good features.

The demand in this country for semi-automatics is expected to rise sharply for a few years, and then hold steady for several years after that. Of course, Hotpoint's decision to introduce the Supermatic was based on accurate forecasting by their marketing department, who were able to discern this trend in 1957.

There is one factor, however, that the marketing department cannot forecast and that is the ever-changing pattern of credit restrictions. It is now the biggest factor of inaccuracy with which they, in common with all other domestic appliance manufacturers, have to contend.

Grand Touring Cars Today

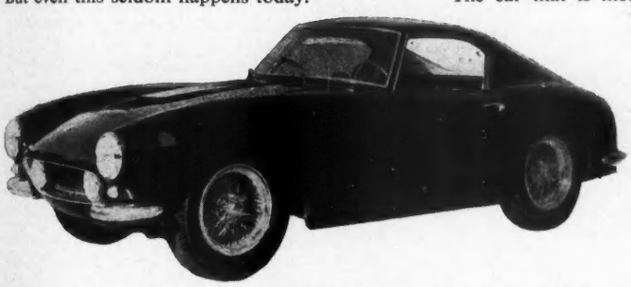
Jaguar are expected to launch a new grand touring sports car immediately before the Geneva Show, which opens on 16 March. Competition in this class is formidable.

By Brian Lister

ONE of the criticisms that has constantly been levelled at the specialised racing sports cars of the last decade is that they bear little relation to the practical road vehicle. The nearest approach to making a road car, from a sports racing car, was the Jaguar XKSS, which was based on the famous D type Jaguar.

Only one or two of these cars were actually produced, although it was planned to build them in some quantity. Naturally luggage accommodation on the XKSS was very limited, and a rack had to be fitted on the back of the body for this purpose. There was a full width fixed windscreen, sidescreens and a hood. A top speed of around 170 mph was claimed, and one would imagine this figure, if anything, was conservative. It is not difficult to see why this has been the only attempt so far to turn a circuit car into a road car.

The C and D type Jaguars were developed from the original road sports Jaguar XK120. The engine and gearbox and rear axle and many of the other components of these cars and for that matter the Mk I 3·4 saloon, were for the most part interchangeable. Again these were the only sports racing cars that have been developed from a standard production car, and it says much for the original Jaguar design. Normally it is the competition car that comes first, and then any useful lessons learned from it are incorporated in a production car later. But even this seldom happens today.



(*Left*) *The Ferrari 250 GT Berlinetta.*

One recent case was the 3·9 litre Aston Martin sports racing car, the engine of which has now been adapted for the DB4 Grand Touring cars.

In 1961 it is likely that we shall see the last of the Appendix C races. More events will be held for Appendix J cars. The essential difference between these two classes is that in the former class, there is no condition on the number of cars that should be produced, whereas in the latter, a hundred at least must be produced in a year. This condition guarantees that the cars will be practical road touring cars.

NEW GT JAGUAR

One advantage of running races for GT cars is that the larger manufacturers are likely to regain interest in racing. In the Appendix C events they were outpointed by many of the small concerns, who are able to develop their cars more quickly, and cheaply, and consequently win many of the races. Also if a standard production car has won an important event, the manufacturer may expect high sales to the growing number of fast touring car enthusiasts all over the world. In addition, running a team of what are really well prepared production cars is much less costly, and perhaps even more important, there is less " time wasting " as far as the development staff of a large car factory is concerned. Their development work is of direct use to both the technical and sales departments.

It is likely that a new GT car will be announced by Jaguar shortly; one hears rumours that it will be presented at, or just before, the International Motor Show, Geneva, which takes place from 16 to 26 March. The new GT Jaguar, it is said, will replace the XK150 and will be fitted with a 300 bhp 3·8 litre engine.

It has been suggested that this engine may have a light alloy block to save weight. This feature is surely unlikely on a production six-in-line engine, owing to the difficulty of ensuring sufficient rigidity. Many manufacturers have experienced trouble in maintaining the rigidity of light-alloy blocks even with those of V-formation. One of the features of the 3·4 and 3·8 Jaguar engines has been their reliability, and it is difficult to believe that they would risk impairing the reputation of this fine engine to save 100 lb or so. It is also said that the new Jaguar has independent rear suspension, which has given the development staff some problems. The performance is apparently comparable with the 3·4 D types with weight around 23 cwt.

It is most unlikely that Jaguar will return to racing in 1961, but if the new car succeeds in competition this year (and motor racing enthusiast Tommy Sopwith, I am told, will be running a team of the cars), it would come as no surprise to see Jaguars re-entering the racing field in 1962. It should however, be emphasised that these views are a matter of conjecture, based on what is happening in the motor industry and motor sport at present. Jaguars have, in fact, officially announced that there is no possibility of them returning to racing this year.

The car that is most likely to be the main opposition to the new Jaguar is the Italian Ferrari " Berlinetta." It was by far the most successful GT car of the 1960 season. Berlinettas won the GT category at the Le Mans 24 Hour Race; they were first overall in the GT race at Goodwood; and first to fifth inclusive in the 1,000 km Paris race at Montlhery.

(*Right*) *The Alfa Romeo Giulietta Sprint Speciale.*

The engine of the 250 GT Berlinetta is a 60° V-12 unit of 73 mm bore and 58·8 mm stroke giving a capacity of 2,953 cc. It has an alloy cylinder block and overhead chain driven camshafts on each cylinder bank. The engine of the car that won the GT class at Le Mans was developing approximately 280 bhp. Similar engines in the " Testa Rossa " Appendix C sports Ferraris, produced between 300 and 325 bhp, depending whether they were factory supported or actual factory cars. I believe there is also a twin camshaft engine of this type in existence, which is said to be giving 356 bhp.

Another challenger from Italy, although one feels by no means as serious as the Ferrari, is the 3,500 GT Maserati coupé. No competition version is quoted in the standard catalogue. The car was a twin overhead camshaft six-cylinder engine giving 230 bhp at 5,500 rpm, a bore and stroke of 86 mm by 100 mm giving a total maximum bhp of 230 at 5,500 rpm. It might be expected that a specially prepared car would give a much higher power output; but it is by no means certain that Maserati are interested in racing the car.

A car which on paper should stand a fairly good chance against both the Ferrari and the Jaguar is the Aston Martin DB4 GT saloon. As mentioned earlier, this model has an engine that was developed from one of their Appendix C cars with a capacity of 3,670 cc.

The chassis is quite conventional, having independent suspension at the front by wishbones and ball-jointed king pins, with coil springs and telescopic dampers. At the rear it is fitted with a live axle on parallel trailing links, located transversely by a Watts linkage, and again coil springs are fitted to the axle, which incorporates large double-acting piston type dampers.

BIG CAR DRIVERS

Inevitably one of the main problems as far as these large-engined cars are concerned will be finding drivers who are used to big motor cars. Most of the current GT and sports-car drivers have had their experience on comparatively small vehicles, and unless a team has sufficient backing to sign up some of the top line drivers who are used to handling all types of equipment, there is little hope of any major wins. It is somewhat shattering to reflect that both the 1960 World Champion and the runner up for the title have scored all their notable wins in small rear-engined racing cars.

It is quite possible that in GT racing this year the Americans will score many more successes in the driving field, simply because they are more used to handling large sports cars than most of our drivers. Well known American big-car drivers include Phil Hill, Walter Hansgen, Masten Gregory, Dan Gurney and Eddie Crawford.

Our most experienced big car drivers are the incomparable Stirling Moss and the very experienced Roy Salvadori. Jim Clark also had experience in a large sports car in his early days of racing, as did Innes Ireland.

In the small GT capacity field the situation over drivers is much easier, and here also performances are more evenly matched. Britain has a very good chance in this section with the Lotus Elite, which has proved itself in GT races last year over and over again, against the best the Continental companies could produce. The Elite is of integral chassis-body construction and is made of glass-reinforced polyester resin. It has a very low dry weight of 11½ cwt, and in standard form the Coventry Climax single overhead camshaft 4 cylinder engine gives a maximum bhp of 75 at 6,100 rpm.

The Lotus Elite's main competitors from the Continent next year will again be Alfa Romeo with their beautiful Giulietta Sprint Speciale. Perhaps, though, an even more serious competitor for the Elite will be the Porsche. The German factory that produces these cars has a great racing background, and in 1960 their Appendix C cars won the Sicilian " Targa Florio " and the United States Sebring 12 hour sports car race. In fact they narrowly missed winning the sports-car world championship from Ferrari, and were also joint winners of the Formula 2 world championship cup with the British Cooper company. As in Formula 1 racing, I would not be at all surprised to see Porsche do exceptionally well in GT events next year irrespective of engine size, which in their case is 1½ litres.

On the Shelf

By Frank H. Smith

THE annual report of the Institute of Advanced Legal Studies always has a generous chunk devoted to the library. It comes as a particularly nasty shock to read in this section, writing of missing numbers, volumes and so on, that "Despite extensive searches, it is clear that many of these had been wrongly taken away by readers. . . . The Committee are now aware that the confidence they have placed in readers assumed to be responsible and honest persons has been abused by a number of them." In view of the body making this comment I do not feel quite so badly about the man who mutilated two separate parts of one of my bound volumes of a journal in order to extract the full text of an article that ran over two numbers.

I am sorry but I cannot afford the Iron and Steel Institute (4 Grosvenor Gardens, London, SW1) translation from the Russian "The theory of creep and long-time strength of metals." It is divided (wasn't it Gaul?) into three parts at £6 10*s* 0*d* each or £15 the lot. Get full details from Martin Wright of the British Iron and Steel Industry Translation Service at the address given. Quote me if you like.

A frightening indication of what's happening in the translation field is the list I have received from the same service. It is *Six-weekly List 19: Comprising Fortnightly Lists 82-84*. The numbers are not consecutive but I see that the highest is 1802. Take time off to boggle.

On the face of it I should not be mentioning *Abstracts of Theses accepted in* 1953-1954 of the Massachusetts Institute of Technology (I wish I could feel confident that you all know MIT), but it was not published ($3·50) until 1960. Compared with the similar publication from our own Cambridge, MIT's titles look very mundane.

A short while ago I think I mentioned the Institute of the Aerospace Sciences' new *International Aerospace Abstracts* at $60 a year (unless you are a corporate member, when it is $40, or an individual member at $20, but then you must not let anybody else see it, so there). Well, the Institute for Scientific Information now offers me *Current Contents of Space and Physical Sciences* at $50 a year if I am educational and $100 if I am industrial. No wonder there are great stacks of gold bricks at Fort Knox or wherever it is. Not that I blame them—in the interests of Anglo-American relations of course. By the way, the IAS is 2 East 64th Street, New York 21, and the ISI at 1122 Spring Garden Street, Philadelphia, 23, Pa.

After the dinner of the British Association of Corrosion Engineers (stainless steel "plate," no doubt), a Mr. C. L. Wilson suggested the formation of an Institute of Corrosion. For further information, get in touch with Miss R. Ruffe Thomas at the BACE, 97 Old Brompton Road, London, SW7.

I see that the current number of *Strain Gage* (*sic*) *Readings* is Volume III, No. 6, but I knew nothing of Volumes I, II and III, 1-5, so if there are others in a like state of ignorance (unallied to bliss) and who wish to put it right, write Stein Engineering Service, 5602 East Monte Rosa, Phoenix, Arizona. They do other material on the same subject—non-U strain gauges.

In their *Proceedings*, the Civils have been describing the virtues of their library and Part 2 (its use) appears in the February number. This particular part reads rather like one of those guide books that the Ministry of Works issues on ancient monuments, and a gridded map to accompany the spiel might not be a bad idea. The description of the basement reads "This contains the overflow of old books and journals." How well I know this since I humped the lot down there in the late twenties—stripped to the Smith waist. It is, actually, the most interesting part of the library.

Timoshenko Takes a Trip Home

Engineering Education in Russia. By STEPHEN P. TIMOSHENKO. *McGraw-Hill, New York and London.* (21*s* 6*d*)

Professor Timoshenko is one of the grand old men of engineering education, and few English speaking engineers can fail to have been indebted at one time or another to his lucid textbooks and papers. In 1958 he made a sentimental journey to revisit the Russian engineering schools in which he had been a student or had taught, forty and fifty and sixty years ago. This slim volume is an account of his tour and of his impressions of current Russian engineering education, together with some historical background.

Particularly to anyone who has had the opportunity to visit Russia recently, it makes fascinating reading as a gloss on the present situation both in Russia and in the United States. How far it is reliable is, however, open to question since errors of fact have crept in, and the volume would have been better if the author had taken his own good advice when commenting on the writings of others: "It is regretful that these chapters are very often spoiled by distortions and exaggerations in those portions describing Russian contributions to the development of science."

He must, for example, be aware that Clerk Maxwell wrote a far more comprehensive account of the theory of governors ten years before Vishnegradsky published his work. Again, when discussing the teaching of the fundamentals of mathematical physics applied to engineering, he appears to be blissfully unaware of the paper on the subject in John Hopkinson's collected works, and the fact that this paper has been the basis of the methods of the Cambridge Engineering School, which for many years was the largest in this country, since 1880.

Where, however, he confines himself to observable facts, as in his visit to the Kiev polytechnic, my own observations confirm his. Anyone wishing for a critical study of current engineering education in Russia might turn to the report published as a paper in the Proceedings of the Institution of Electrical Engineers.

D. B. WELBOURN

No Science is an Island

Science Survey I. Edited by A. W. HASLETT and JOHN ST. JOHN. *Vista Books.* (25*s*)

Frontiers in Science. Edited by EDWARD HUTCHINGS, JR. *Allen and Unwin.* (25*s*)

Men and Molecules. By CARL R. THEILER. *George Harrap.* (21*s*)

From Galaxies to Man: A Story of the Beginnings of Things. By JOHN PFEIFFER. *Victor Gollanz.* (21*s*)

The Simplicity of Science. By STANLEY D. BECK. *Lutterworth Press.* (16*s*)

Eye on Research. By G. RATTRAY TAYLOR. *John Murray.* (16*s*)

Scientific Research in British Universities, 1959-1960. *Department of Scientific and Industrial Research: HM Stationery Office.* (25*s*)

For all the concern about "the fragmentation of science" and "the two cultures," the production of synoptic, interpretative and explanatory literature on science and engineering is large and varied—and its commercial success is significant. The books under review were all published within a few weeks of each other.

Science Survey I, although the work of thirty-one contributors, each writing on his own specialism, is remarkably successful in conveying a sense of the unity of science. The linkages between the growing-points of research, as well as those between science and technology, are suggested even by the titles of the seven sections: the stuff of the universe; arranging atoms for industry; cells, viruses, and heredity; radiation and fall-out; organisms and their behaviour; the earth; space exploration. The book is well illustrated by photographs: perhaps the most exciting are the electron micrographs of the bacteriophage, showing how, at a magnification of about half a million, the level of organisation at which the geometry of the molecule practically determines the simplest mechanisms of animal behaviour is almost *visible*.

Frontiers in Science is more of an anthology, a selection of articles from the American journal *Engineering and Science*, but here too the degree of interconnection is striking. It is also made explicit in brief introductory essays to the main sections: the biological sciences; the physical sciences; science and society. The style is lively. One essay in the last section is worth mentioning as delightfully entertaining as well as instructive: "A case study of innovation"—an account of administrative action and reaction when continuous-sight firing was being introduced into the United States Navy at the turn of the century It is a "human factor" story with lessons of wide generality. An excellent bedside book.

Men and Molecules has been translated from the German. The first two chapters present a few incidents in the history of chemistry; the remainder describe recent achievements of chemical industry—drugs, scents, fibres, plastics, aluminium and glass. I found this book disappointing: rather too many of the little human interest stories (most intelligent readers nowadays are prepared to assume the humanity of even their most brilliant forebears), too many exclamation marks, and too many photographs of chemical engineering plants that all look much the same agglomeration of towers, cylinders and pipes. The level of explanation is uneven, and readers who know enough of the subject to follow the later chapters are likely to be put off by the style of the earlier ones, for example: "Just as letters unite to form words, so atoms unite to form molecules." Perhaps this sort of treatment just does not translate very well from German into English.

From Galaxies to Man is difficult to review fairly in a few words. A couple of quotations may convey why:

> Ten billion years ago. A long, long flight back over the deserts of times past, beyond the memory of oases and mirages. In the flight the entire span of human history and prehistory is the upstroke of a single wing beat. A few moments ago, on that time scale, hunted creatures no longer apes and not yet men wandered in packs in a world which still belonged to stronger and swifter animals.

And again:

> An observer would notice nothing spectacular. Perhaps only a slight cloudiness in the water. But reproduction has begun and it is here to stay. It is like a weak, cool blue sputtering which becomes a flame and then many flames. This fire of breeding molecules is not alive. Not yet. It does not yet have the trappings of life, but it has the essence. It spreads and it will spread further, and evolve. All living things, including ourselves, are to be the descendants of those spiral patterns.

One man's meat and another man's poison. Some of these purple patches, however, are provocative. The "layman" would probably get an odd idea of the methods of science from this book, but a reader who is generally familiar with the field covered might well find his imagination stimulated and his sense of wonder reawakened—and that is no small thing. At least the idea of *process* is insisted upon here. So much of science is comparable to the production

of still photographs, or perhaps of film strips. Mr. Pfeiffer here presents a 3D ciné film, and perhaps we shouldn't cavil overmuch at the glorious Hecticolour.

The Simplicity of Science sets out to present the basic concepts, assumptions, and methods of science. The nature of an experiment, an hypothesis, a theory; the ideas of cause-and-effect, of probability, of life; the relations of science to faith and belief—all these are discussed with familiar examples. Dr. Beck is a professor of zoology—one of the more favourable background disciplines for presenting a study of this character.

This kind of book should be essentail reading in every sixth form, but somehow this particular book succeeds in being a little dull, an impression reinforced by a dull dust-jacket, dull typography and the absence of illustrations. This is a pity, because the subject can be brought to life, and it is rather neglected. It is often regretted that students specialising in physics, chemistry and other subjects are taught little of the arts, but one sometimes has the impression of an even more serious omission: that they are taught too little of the nature of science itself.

Eye on Research is the book of the television programme, an account of work in progress in eleven research fields, mainly on biological and engineering problems, with a thread of commentary on how this material was assembled to form a visual record. There seems to be no doubt at all that television is doing more than any other single medium of communication in giving a very large number of people some idea of what science is all about: it is the growing-point of journalism. This book, too, has the quality of good journalism.

Scientific Research in British Universities 1959-60 is a catalogue of titles of items of research in progress, arranged by universities, with name and subject indexes. It runs to nearly 500 pages.

It is the first two books, in particular, that have been done least justice in these brief notes. These are "front-line despatches," addressed to responsible people in other walks of life—people who need to know where stand the frontiers of knowledge, and into what sort of country current advances are leading. For over a century our most gifted scientists have been writing, in this way, for their intellectual peers in other disciplines, but it is only recently, perhaps, that this sort of communication has become really vitally important. Hitherto, the influence of technology on living matter has been localised in space or in time. However great the shambles—dust-bowl or theatre of war—they were not essentially different from natural catastrophes. Starvation, disease and mutual extermination have been part of the selection process through which life has evolved over two thousand million years. Now, however, technology has created something really new: the possibility of changing, over the whole surface of the earth, the background determining condition of evolution itself—the level of radioactivity and hence the rate of mutation among all forms of cell life.

Some of the earliest and most ingenious science fiction was based on a simple pattern: just suppose *one* little natural fact were otherwise. Suppose, for example, that water contracted as it cooled, all the way to its freezing point: then life as we know it could not have evolved on earth. Suppose some other boundary condition had been different—or can be changed at this late stage in the experiment? This is no longer fiction. We are concerned. And there is some evidence that the realisation of technological potentiality can be controlled by political, economic and even ethical considerations (in the Second World War, gas and bacteria were not used as weapons . . .).

Some of the chapters in these books, therefore, are important in a new way; and, significantly, all the books carry some reference to the hereditary future. Two papers in *Science Survey* and one in *Frontiers in Science* are directly concerned with this problem. Their authors, thanks be, are not confidently reassuring, but even so, one is uncomfortably aware that different types of inference can be drawn from one set of facts.

For example, we learn that " . . . we live in a remarkably radioactive environment and that this has been so for a long time. Yet in spite of this the human somehow contrives to keep his natural radioactivity (per gram of tissue) to the very low levels we have observed." The facts here are: (1) the environment, including food, contains radioactive material, and (2) a human body contains less radioactive material than would be expected from the amount ingested, unless there is a mechanism for its selective elimination.

On these facts, one *might* put the optimistic construction that we have some sort of biological mechanism that protects us against increases in radioactivity, so perhaps things are not so bad. But there is the less comforting inference that survival has depended on maintaining the body's radioactive content below a certain level, and hence on the evolution of biochemical controls to ensure the almost complete elimination of radium and thorium; hence what happens when other chemical elements, against which the organism has not "learned" to discriminate, become important carriers of radioactivity?

Obviously this line of inference will not have escaped the investigators, and presumably other facts invalidate it. It merely exemplifies how important it is that scientists, when presenting their conclusions for critical assessment on the economic, political or ethical level, should distinguish clearly between fact and inference and should try and avoid leaving loose ends of interpretation that might leave a careful (but relatively uninformed) reader feeling sceptical—or even scared.

G. E. DENYER

Partners in Trading—Partners in Research?

Swedish Export Directory, 1960. 42nd edition. *The General Export Association of Sweden, Vasagatan 12, Stockholm; Swedish Chamber of Commerce for the United Kingdom, 14 Trinity Square, London, EC3.* (70*s*)

When the European Free Trade Association came into existence in 1959 it brought within one tariff system two of the most skilled and quality conscious engineering industries in the world, namely the British and the Swedish. It is often said that the prospect for Britain's high quality engineering products in Germany is good, if ever entirely free competition comes into existence between the two countries, because the Germans tend to manufacture the simple and robust, while they appreciate the precision and general excellence of the British product. It is a generalisation which oversimplifies the position but has some truth in it for all that.

No such argument is heard about the Swedish industry. Its reputation in its chosen fields, such as shipbuilding, heavy and light electrical engineering and certain branches of mechanical engineering could not be higher. Its impact on British engineering markets has been felt in common export markets and in the United Kingdom home market, not least in the establishment of subsidiaries over here. This country has been slow to appreciate the skill which has been deployed by Sweden with its 7 million population and cheap hydroelectric power to build up a highly selective, powerfully competitive engineering industry paying good wages and high managerial salaries.

The establishment of the EFTA is going to give this country the opportunity to see Swedish competition at work over here unencumbered by tariffs, though tariff cuts may take effect in different industries at different dates. It will be a chance to learn. Competitively the Swedes have an edge in as much under EFTA they are dismantling a tariff wall which is generally lower to start with than the United Kingdom's.

In all this it will be well to watch the Swedish trade literature and other promotional material. This *Swedish Export Directory* 1960 is a good example of what a handy-sized export directory ought to look like. It is symptomatic of a thoroughness which is likely to run through all the Swedish approach to the UK market as tariffs come down. Its indexing methods (the essence of a good trade directory) are carefully thought out and its layout and production are of a high standard. Only those who use it can find out whether it avoids the bane of all such publications—offering information, long since out of date. But in any case the next edition will soon be out.

G. E. TEWSON

Scandinavian Research Guide. 2 Volumes *Scandinavian Council for Applied Research, Gaustadallen 30, Blindern, Oslo, Norway.* (70 N·Kr)

The publication, in English, of a Scandinavian research guide by the Scandinavian Council for Applied Research draws attention to the impressive level of research activity in the Scandinavian countries, which here include Denmark, Finland, Iceland, Norway and Sweden.

The research guide gives concise and detailed information on over 1,500 research institutions in Scandinavia covering all fields of science and technology, with the exception of the medical sciences. It excludes private industrial research laboratories, but includes cooperative industrial research associations.

The information given includes the full name, both in the original Scandinavian language and in English, the address and telephone number of the institute, the names of department heads, number of staff and a short statement on the main field of work undertaken at each institute or research department.

The guide is published in two volumes. The first volume, which comprises Section A, provides a list of research institutes and laboratories arranged under subject matter, classified according to the Universal Decimal Classification system. In the second volume are Section B, a classified list of research councils, academies and parent research organisations and committees; Section C, the universities, colleges and institutes of technology; Section D, the scientific and professional societies with their technical publications; Section E, the central scientific technical libraries, information and documentation centres; Section F, productivity centres and committees; and Section G, a bibliography. There is finally an index, cross-referenced according to the subject, institution or laboratory, and a name index.

The guide is certainly more ambitious and covers a wider field than anything of its kind yet published. It should be of great value to anyone with a special interest in international scientific and research contacts. It should certainly have an important place on the bookshelf of every export manager selling scientific and engineering equipment to the Scandinavian countries.

It is possible that some of the post-war developments in Scandinavian research are not widely realised outside Scandinavia, and that some of the research laboratories listed in this guide may not be known to British readers. There is, for instance, the remarkable growth of sponsored research in Norway with the large new

Central Institute at Blindern, near Oslo, which now has a total staff of over 150, the small but highly efficient Chr. Michelsen Institute in Bergen with some 40 people and the interesting organisation of SINTEF—the engineering research foundation at the Technical University of Norway in Trondheim, which operates as a commercial research unit within the university where it has the dual purpose of providing industry with research results and of gaining industrial support and bringing industrial problems into the work of the Technical University. The SINTEF type of organisation is perhaps something which could be usefully adapted to some of the more technical universities in Great Britain.

There are also many much smaller institutes or research departments listed, of whose existence many workers in the same field in this country would possibly not have been aware, without consulting the Research Guide. It could perhaps be a useful exercise if directors of research laboratories and those in charge of research projects were to study their own subjects as listed in the guide and see how many laboratories there are in Scandinavia working in the same field of whose existence and activity they may have not been sufficiently aware. To take only one example, there are 14 institutes or research departments working the field of biochemistry. These range from the well known Institute of Biochemistry at Uppsala University under Professor Tiselius to much smaller biochemical departments at some of the universities in Finland and in Denmark. A similar pattern can be found for many other subjects.

In some cases, particularly where an important Scandinavian industry is concerned, there may be a very considerable research and development effort. Supporting the timber industry with research in such subjects as wood technology, wood pulp and paper and fibre board, there are no less than 34 research institutes or departments.

It might be expected that with so many laboratories working in closely related fields there is some danger of duplication of research effort. That the Scandinavian countries are aware of this danger is shown by the existence and purpose of the joint Scandinavian Council for Applied Research. And there is an increasing trend towards cooperation, joint research programmes and sharing of research effort among the Scandinavian countries so that with their relatively small populations they can utilise their research effort to the greatest effect.

For instance, some proposals have recently been adopted within the Scandinavian pulp and paper industry to bring about annual meetings of representatives of the governing bodies of research associations; half-yearly meetings of heads of research laboratories to discuss current and projected research work; exchange of publications and research results of a non-confidential nature; standardisation of testing and other analytical methods; the utilisation and sharing of special equipment and apparatus; coordination of research programmes; exchange of staff, and so on.

The Scandinavian countries are of increasing importance as trading partners of the United Kingdom, particularly in view of the formation of the European Free Trade Association, in which our trade with Scandinavia accounts for over 80 per cent of our trade with the EFTA countries. It is to be hoped that the publication of the Scandinavian Research Guide in providing a useful and valuable source of information on research in Scandinavia will help to bring about closer relations between British research institutions and industries and their counterparts in Scandinavia.

There may well be some special fields where the type of coordination of research effort referred to above could usefully be widened to include both Scandinavian and British research institutes. The fact that the Scandinavian Research Guide itself is published in English shows that at the technical and research level there is no language barrier between the two countries. The Scandinavian Research Guide can be obtained from the Scandinavian Council for Applied Research, Gaustadalleen 30, Blindern, Norway, at a price of £3 10*s* 0*d* for the two volumes. The purchase of this book is strongly recommended.

G. H. GREENHALGH

Who Can Afford These Curious Materials?

Symposium on Newer Metals. ASTM Special Technical Publication No. 272. *American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.* (\$7·25, *members* \$5·80)

One consequence of the breakneck speed of advance in technology is the almost febrile search for new materials to meet the more and more exacting requirements of designers of aero engines, nuclear reactors and the like. Among these materials the so-called newer metals rank high in importance. They are the subject of a vast amount of research and the spate of publications on their properties and uses now in full flood can be expected to continue for some time.

Thus the engineer-designer can make his choice between up-to-the-minute accounts of detailed investigation in technical journals, which still require public debate before their significance or authority can be established, and monographs in which much of the cut and thrust of technical argument has been resolved and a considered statement can be presented.

The present book lies between these two extremes, being a collection of papers presented at a symposium on new metals held in San Francisco in October, 1959. Some describe results of original investigations, others are reviews of current knowledge and practice. The choice of subjects appears to have been arbitrary although an attempt has been made to separate the papers into logical groups, namely refractory metals, nuclear metals and methods of processing.

In the refractory metals group are papers on mechanical properties of molybdenum alloys in sheet form with particular reference to factors affecting ductile-to-brittle transformation temperature; high temperature properties of tantalum; effect of oxygen and nitrogen on workability and mechanical properties of niobium and the efficacy of vacuum levitation melting as a method of purification; properties of the platinum group metals; and an account of attempts to produce ductile chromium metal by adding scavenging elements.

Supporting these papers on properties is one describing a machine for tensile and stress-to-rupture testing of metals at high temperatures in either high vacuum or controlled atmosphere, and papers reviewing fabrication methods for niobium, tantalum and tungsten.

In the nuclear metals group are three papers on Zircaloy-2, the zirconium alloy used for structural components in pressurised-water reactors. Here preoccupation is with corrosion resistance and the need to control heat treatment as well as purity during manufacture to keep reaction with high-temperature water at a minimum. The papers include a study of the effect of heat treatment on weight gain in high-pressure steam with check data on the influence of these treatments on mechanical properties of the alloy at room temperature; a description of a coulometric method for determining tin in zirconium alloys; and a rather superficial review of test methods laid down for Zirconium-2 in the United States Naval Reactor Program.

Yttrium has recently come into the foreground of new metals as a relatively strong material of low neutron cross-section, particularly in the work-hardened condition. There is an account of some work on effects of metallic and non-metallic alloying additions on its capacity for strain hardening and related loss in ductility. Yttrium also appears to be the most efficient scavenger of nitrogen in liquid lithium, purification details of which are described in another paper.

Lithium is included as a possible high-temperature liquid-metal coolant. The nuclear fuel metals are not discussed. There are two papers dealing with the mechanical properties of beryllium, which although nominally a nuclear metal, is technically very attractive in the aircraft and missile field as a high-strength ultra-light metal with an exceptionally high elastic modulus.

The book is attractively and sturdily presented although some of the diagrams of apparatus suffer from having been reduced too much from large drawings and the fine detail is in consequence confused, all the more regrettable as there is a bare minimum of description of apparatus in the text. Brief lists of references are appended to most of the papers but there is no index.

Having read the book from cover to cover and digested the somewhat heterogeneous collection of papers, the reader may well find himself pondering—not for the first time, perhaps—the basic problem posed by the rapid development of so many new, interesting but expensive materials—who will be able to afford them?

J. W. RODGERS

New Books

Betriebstechnik: Grundlagen. Dechema Monographien, Band 32. *Published for Deutsche Gesellschaft für Chemisches Apparatewesen by Verlag Chemie, Weinheim/Bergstrasse.* (48·80 *DM*; members 39 *DM*)

Papers, 26 in all, some of them augmented, presented at meetings held within the framework of the European Congress of Chemical Engineering and the Second ACHEMA Congress.

A Compendium of Spherical Astronomy. By SIMON NEWCOMB. *Dover Publications, New York; Constable, London.* (18*s*)

All the basic mathematical methods of determining, correcting or reducing observations of fixed stars. Facsimile reprint of the 1906 edition.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Generator. PETBOW LTD., Sandwich, Kent. Arc-welding generator designed to withstand vibrations of diesel drive. Auxiliary power output of 8 kW for hand tools. Sets described in folder. 4 pp. ill.

Weldability. ENGLISH ELECTRIC CO. LTD., English Electric House, Strand, London, WC2. "Weldability" is a simple guide to better welding, with much detail information. 56 pp. ill.

Stud Welding. RESEARCH AND CONTROL INSTRUMENTS LTD., 207 King's Cross Road, London, WC1. Philips stud welding process and apparatus described in folder. 4 pp. ill.

The Reviewers

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Marketing

Ship to be Built in Two Countries

AN AMSTERDAM shipbuilding company are to build an 11,900 ton motor ship for a Lisbon concern, but the hull will first be built in Portugal and towed to Amsterdam for completion, including installation of the engines.

The Netherlands shipyard are the NEDERLANDSCHE DOK EN SCHEEPSBOUW MAATSCHAPPIJ and the order has been placed by the COMPANHIA NACIONAL DE NAVEGACAO, of Lisbon. The high speed motor ship is to have accommodation for 12 passengers. She will be finished by early 1963. Not only is the Portuguese built hull to be made to designs provided by NDSM but the Amsterdam company will also send the materials to Portugal.

Finland Exporting to North America

The increasing Finnish effort to diversify the range of its export effort is meeting with a number of successes. Probably no country in the world is more associated with farm mechanisation and exports than Canada, but the Finnish manufacturing group METEX have reached an agreement with the Canadian FORANO company to market a new reaper made in Finland.

Against fierce United States home competition in the shape of nine other tenders, YRJÖ HEINONEN won an order for a new indoor sports track at the Los Angeles arena. The track, constructed in spruce and pine, has been made under Finnish supervision and by Finnish workers.

There are indirect benefits too. The Finnish INSTRUMENTARIUM firm exhibited its newly designed spectacle frames in New York recently. A German concern—METZLER—followed this up and bought the rights to produce two of the models.

In the United Kingdom a new factory is to open in Hull, Yorkshire, this month, manufacturing paper sacks. The company—PAPROPACK—will be 50 per cent owned by the Finnish corporation, W. ROSENLEW. Raw material will be brought from Finland.

Fairfield Turbine Agreement with Westinghouse

A licensing and technical assistance agreement has been signed by the United States WESTINGHOUSE ELECTRIC INTERNATIONAL Company and FAIRFIELD SHIPBUILDING & ENGINEERING, of Glasgow, the major shipbuilding firm of the LITHGOW GROUP.

The licence gives Fairfield's exclusive rights within the United Kingdom for the production of marine turbines incorporating Westinghouse techniques. Sublicensing of other turbine builders in Britain will be possible. The agreement gives Fairfields some of the benefits of the prolonged research programme carried out in the research centres of the Westinghouse company.

Back in 1958 Fairfields provided for their engineering interests in nuclear marine propulsion by joining in the consortium formed with MITCHELL ENGINEERING, of Peterborough, and COMBUSTION ENGINEERING, of New York.

Fuel Injection Firm to Have Own Computer

CAV Limited, who supply fuel injection and electrical equipment to diesel engine and vehicle manufacturers all over the world, have ordered a LEO III computer from LEO COMPUTERS Limited. CAV's association with computers goes back to 1955 when they made use of LEO I, the first of the family, for injection research and other engineering problems.

The company has been using the LEO II service for some months in the production of daily labour efficiency calculations and on payroll work. CAV's own LEO III will also handle payroll preparation. In addition, it will be used for production scheduling and control of the three United Kingdom factories, at Acton, Rochester and Sudbury. The equipment is to be installed in December of next year. Before then some of the jobs will be running on a pilot basis at the new LEO III service station for several months in order to give a considerable operating load at the start.

The fully transistorised computer will print its results on a high speed printer at 880 lines a minute. Special arrangements ensure that the computer never has to wait for ancillary equipment to catch up with it. By sharing its large magnetic-core store, several jobs can be carried on simultaneously.

For the benefit of the maintenance engineers, special breakdown exercises have been worked out.

Balderhead Reservoir Contract for Costains

One of the largest dams in the United Kingdom, 150 ft high and 3,000 ft long, is to be built by RICHARD COSTAIN (CIVIL ENGINEERING) for the Tees Valley and Cleveland Water Board's Balderhead reservoir.

The contract is worth almost £2·4 million and with work starting at once the construction is expected to take four years. The consulting engineers are EDWARD SANDEMAN KENNARD AND PARTNERS.

Pump and Cultivator at Cairo Agricultural Show

Jointly developed by agricultural engineers in England and Ceylon, the Landmaster 150 rotary cultivator is to be shown with its full range of attachments at the Cairo International Agricultural Fair next month.

The cultivator is made by the LANDMASTER company, of Nottinghamshire, a member of the FIRTH CLEVELAND group of companies. The controls of the cultivator are so designed as to be easily used by unskilled workers, its first cost and running costs have been kept low and it can be fitted with the reversible plough in use in the East as an alternative to the normal European rigid mouldboard plough.

FIRTH CLEVELAND PUMPS, who supply self-priming centrifugal multi-stage pumps to the Sudan Government, are showing a 3 in irrigation pump. This is a trolly mounted single stage self-priming centrifugal pump fitted with an 8 hp JAP petrol engine.

Volta Project Bids Opened in Accra

Within a very few months work should be beginning on the £70 million Volta River project in Ghana and the Ghanaian authorities are vigorously looking round for a chief executive to direct the entire scheme.

President Nkrumah has said that he expects the contract for the river scheme to be awarded in April. Work should be under way by the end of this year and the first power flowing from the hydro-electric project by September, 1965.

Arrangements for the loan of £30 million towards the scheme by the World Bank, the United States Development Loan Fund, the Export-Import Bank of Washington and the United Kingdom Government are expected to be completed shortly. Ghana is providing £35 million from her own resources and is also approaching the United States Government for a further £10 million loan.

First bids for the project have been opened at a public meeting held in Accra. The bids opened were jointly from MORRISON-KNUDSEN, of the United States, and TAYLOR WOODROW, of Great Britain; from IMPRESIT, of Italy, with CIROLA and LODIGIANI, and from VOLTAIC INTERNATIONAL CONSTRUCTION, which includes GAMMON JOHNSTON DUCK AND PIPER, TORNO, of Italy, and CHRISTIANI AND NIELSEN, of Denmark. These are for the first stage, including the 2,100 ft long Akosombo Dam.

Morrison-Knudsen and Taylor Woodrow's tender was £21,214,000, and with an alternative plan (involving the lowering of two intake penstocks by 30 ft) their tender was £21,431,000. The British participation in the Anglo-American group is shared in the proportion 80 per cent Taylor Woodrow and the remaining 20 per cent equally between WIMPEY and LAING. The Impresit bid was £15,723,000 and £15,903,000.

Voltaic, who did not conform to the contract condition which required protection against labour increases and fluctuation of fuel prices, quoted £14,821,000 and £14,947,000.

Two further bids have yet to be opened. For them, the Ghana authorities will hold another public meeting when the consulting engineers—KAISER—have made their inquiries into the qualifications of those tendering. These are from the PARKINSON HOWARD AND ASSOCIATES grouping and from the TRANS-VOLTA Company.

Parkinson Howard and Associates includes in addition to the principals Sir Lindsay Parkinson and John Howard, CEMENTATION, ROYAL DUTCH, and RANSOME AND RAPIERS; the group is currently building Tema harbour and roadworks in the Volta area.

The draft agreement on the building and operating of the £100 million aluminium smelter associated with the Volta project has also been published in Accra. This is between the Ghana Government and the VOLTA ALUMINIUM Company. This organisation is made up of KAISER ALUMINIUM, ALCOA, REYNOLDS ALUMINIUM and OLIN MATHIESON.

The company will be exempt from all duty, including import and export levies, for 10 years. Tax rates will be held at the present level for thirty years for Valco. A No Nationalisation clause guarantees freedom from such action for thirty years and after that only with prompt and just compensation.

Dynamometers for Russia

HEENAN AND FROUDE, of Worcester, are to supply MACHINOIMPORT, one of the Soviet purchasing organisations, with two large hydraulic dynamometers.

The dynamometers are rated for a maximum of 25,000 bhp at speeds up to 6,500 rpm. They are suitable for the testing of powerful gas or steam turbines and could be coupled in tandem to test turbines developing as much as 50,000 bhp.

One of two previous dynamometers ordered by Machinoimport, rated for 16,000 bhp, was dispatched to Russia last November. The Worcester company's exhibits at the British Trade Fair in Moscow in May will include a much smaller example suitable for testing road vehicle engines.

Fawley £4 Million Butyl Rubber Plant

FOSTER WHEELER are to build the new £4·3 million butyl rubber plant at Fawley refinery, Hampshire, for the ESSO PETROLEUM company.

Major outlets for butyl rubber are foreseen in motor car tyres, and in electric cables, conveyor belts, tank linings and components. Production is expected to amount to 30,000 tons a year and the plant should be complete by the end of next year.

At the moment the United Kingdom's supplies of butyl rubber are imported from the United States and Canada. No site has yet been confirmed for the butyl rubber plant which the POLYMER CORPORATION OF CANADA has announced is to be built in Britain.

Another Record Year for Office Equipment Exports

With a 25 per cent improvement over 1959 in its export earnings for 1960, the United Kingdom office machinery industry was arguing from strength when one of its leaders asked Mr. Reginald Maudling, President of the Board of Trade, for Government support in breaking overseas import quotas, raising tariff rates and for some relief from Purchase Tax.

The petitioner was Mr. E. F. Lewis, president of the OFFICE APPLIANCE AND BUSINESS EQUIPMENT TRADES ASSOCIATION, speaking at the quarterly lunch of the Association. Mr. Maudling, who had observed that the standards of British industrial production were not always equalled by the art of salesmanship, assured the industry that the Government would do its best to "press all the time" for greater facilities in the export field.

The exports of the office equipment makers in 1960 were worth £34,060,434, compared with £27,228,608 in the previous year. The outstanding buyers were Australia, the United States, Canada and Western Germany.

Deliveries of office machinery from the British companies in the first ten months of 1960 suggest a substantial rise in the industry's output for 1960.

Closed Circuit Television Aids Car Production

Thirteen Marconi closed circuit television camera channels and associated equipment form an integral part of a new automatic routing system to facilitate the inspection of car bodies at the Standard-Triumph Motor Company's works at Coventry. The installation is claimed by Standard-Triumph to be unique and the most advanced in the world in terms of efficiency and rigidity of control.

Car bodies arrive on conveyor belts from the manufacturing areas into a new extension hall for inspection. Each vehicle is carried in a special skip which incorporates trip devices peculiar to the particular type of vehicle being carried. These trips actuate routing mechanisms on the conveyor system which channel the vehicles to their correct destinations in the inspection area. Here, they undergo a series of inspections before the "passes" are delivered automatically to other floors and any rejects are diverted along a rectification line.

The CCT installation fulfils a number of functions in the routing and inspection processes. The cameras which are installed at strategic points within the area feed their pictures to a central control room. Here, five Marconi 14 in monitors provide pictures from five cameras mounted in different parts of the body storage area to enable controllers to identify the various types of car body passing along the conveyor belts and to keep the programming department constantly informed of the current position. Details of body colour and other relevant data are carried in code form on a card on each vehicle.

Any of the eight remaining cameras can be switched to the sixth picture monitor and this enables a controller to keep a close watch on the passage of vehicles at all stages of progress. He can ensure that no mishap occurs; he can check that the bodies are moving along their programmed routes; he can foresee where bottlenecks are likely to occur and take steps to avoid them, and generally expedite the progress through the inspection area. The use of television thus enables all this supervision to be carried out from a central point and removes the necessity for men to be stationed at strategic points equipped with an open telephone to the programming department.

The Marconi installation consists of 13 camera channels type BD871 and eight 14 in picture monitors type BD879, together with ancillary equipment. The 13 control units which form part of the camera channels are contained in a single rack-mounting unit with an oscilloscope for monitoring purposes.

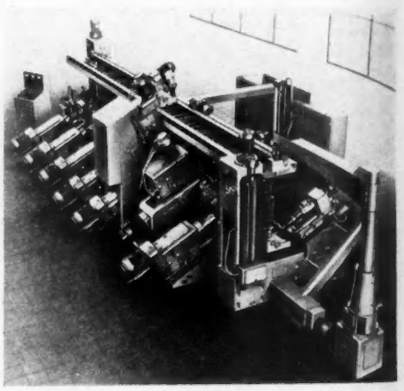
A close-up of one of the 13 television cameras surveying a body hoist area.

Automatic Machining of Bearing Boxes

An automatic transfer line, TOS-001, for machining the bearing boxes for railway wagons is in service at the SKF Works, Czechoslovakia. Developed at the TOS factory, it incorporates nine working stations and a total of 22 work spindles. The line is completely automatic: 44 operations are carried out in sequence in a period of 220 seconds.

At the first station the workpiece is automatically centred and clamped. The transfer plate with the clamping attachment is then brought to individual working stations where the respective operations are carried out. These include boring, facing, recessing, spot facing, chamfering, drilling, counter-boring, milling, and cutting of cylindrical and tapered threads. At the 9th station the workpiece is unclamped, suspended on the hook of a crane and, after being swivelled through 90°, is put on a cooling rack. At the same time the transfer plate and clamping attachment, now empty, are lifted on to a return conveyor to the first station.

The nine working stations form entirely independent units, interconnected by the transfer plate shifting equipment. Boring and milling units are operated hydraulically, while the spindles of the thread cutting units are fed into the cut by leaders. Through the centre of the bottom part of the transfer line passes a worm chip conveyor which delivers the chips by means of an elevator into containers. All functions of the transfer line are operated electrically by means of buttons on the control console. Should any of the tools become blunt the transfer line automatically comes to a standstill and a signalling device indicates the tool to be changed.



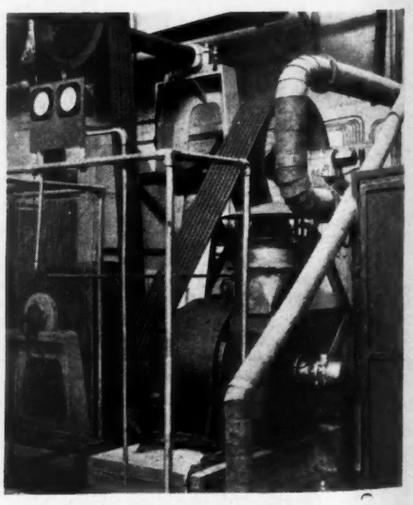
The automatic transfer lines.

Maintaining Constant Speed Under Varying Loads

Equipment for a 95 hp variable speed paper machine drive has recently been completed and delivered to Alders (Tamworth) Limited by Crompton Parkinson in conjunction with Brookhirst Igranic Limited. The paper mill at Tamworth has been in existence for almost a 100 years, and the equipment supplied was made for a 120 in trim width MG paper machine producing papers mainly for the packaging and advertising industries. The reason for the introduction of the new drive was to improve the regulation, so that the change in speed with load variations could be reduced, and also to raise the maximum speed of papermaking from about 360 ft per min to a little above 500 ft per min.

Crompton Parkinson supplied equipment consisting of a 95 hp, 0/500 V, forced-ventilated dc motor having a speed range of 1,600/320/150 rpm by Ward Leonard control. This motor drives a line shaft through V belts and the line shaft in its turn drives the various sections of the machine through pneumatic clutches. The necessary dc power for the motor is provided by a two-machine motor generator set comprising an auto-synchronous unity power factor motor fitted with overhung exciter driving a 0/500V shunt wound separately excited generator.

The control gear for the dc side of this Ward Leonard system was provided by Brookhirst Igranic and consisted of a main control cubicle together with a small remote control station. The equipment was intended to give two forms of control. The first of these, termed hand control, was very similar to conventional Ward Leonard equipment in that the main magnetic amplifier was controlled by a hand rheostat to give variable voltage output to the main generator field, thus controlling the speed of the machine but without incorporating the feedback circuit for improved speed regulation. The other form of control, termed auto control, which would normally be used, makes use of a servo principle of operation in which the motor speed is not controlled directly by the speed setting device. Instead, it is governed by the error which exists between the desired speed and the actual speed. A two-stage magnetic amplifier is used to control the generator field and, for reference purposes, Zener diodes are incorporated. Speed regulation has been kept within $\pm\frac{1}{2}$ per cent despite $\pm$ 10 per cent changes in load. The speed variation from no-load to full-load does not exceed $\pm$ $1\frac{1}{2}$ per cent.



The main variable speed dc motor.

Solid State Generator for Ultrasonic Cleaning

A small and compact cleaning system has been introduced by the ultrasonic division of Branson Instruments Incorporated of Stamford, Connecticut, USA, for the production cleaning of small parts and sub-assemblies. Called the model LG-75, the unit is powered by a 75 W generator driving a transducerised tank at a nominal frequency of 25 kc/s.

The generator is fully transistorised and thus should have a relatively long life with a minimum of maintenance—as compared with similar units employing vacuum tubes. The generator cabinet measures 12 in by 10 in by 5½ in high.

The power output of this ultrasonic cleaning system is 75 W.

The apparatus has only two controls. A panel mounted switch turns the generator on, applying the 75 W high frequency power output to either of two Sonogen-Z transducerised tanks, for conversion into mechanical vibrations of the same frequency. One of these tanks is for cleaning and the other for rinsing. A full wave generator signal, which, it is claimed, cleans the most stubborn stains quickly and thoroughly is possible with this system because the transducers used are capable of handling larger amounts of power than conventional transducers. The second control matches the generator output to prevailing conditions when the equipment is first placed into operation.

The two transducerised tanks can have capacities of either one or two gallons and are made from stainless steel. Thermostatically controlled heating elements for temperatures up to 200° C are optional extras. The smaller tank has an extremely high acoustic output and is designed for difficult or fast cleaning. The larger tank is recommended for volume applications where speed and economy are desired.

Cutting Keyways

A few months ago, the Mortimer Machine Tool Company Limited of London, NW10, supplied what is thought to be tthe largest keyseating machine ever built to the Manganese Bronze and Brass Company Limited. The machine was designed and built by Firma Fromag of Frondenburg to cut keyways in particularly long and large bores. The machining range is for keyway widths from 1⅛ in to 7⅛ in in bores from 11¾ in to 4 ft 11 in diameter, the maximum length of bore of the component being 6 ft 6 in.

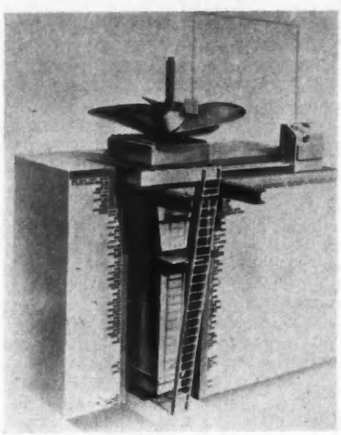
The Manganese Bronze and Brass Company has to machine very heavy propellers with a maximum load capacity up to 70 tons. To simplify operation, the machine is constructed so that only the headplate is above the toolroom floor level, while the other part of the machine body is arranged underneath the floor in a foundation pit. The control console stands at a distance of approximately 20 ft from the machine, so that even very large components, with an external diameter of 39 ft, can be machined.

Due to the difficulty in setting up heavy components in the right position, the machine has been fitted with a floating table, so that the normal lifting facilities need only put the components down in approximately the right position. They can then be adjusted into the exact location by means of the floating table. This floating table runs on rollers, and to prevent the rollers being damaged when a heavy load is put on to the table, the table is equipped with a hydraulic lifting device, which allows the component to be set down on to the table and then hydraulically lowered on to the rollers.

To enable taper keyways to be cut, which are always necessary for the manufacture of ships' propellers, a canting table is supplied in addition to the floating table.

The machine is driven hydraulically, and the main controls and the control gear for the hydraulic circuit are mounted in the control cabinet. An adjustable high pressure axial piston pump is driven by a 10 hp flange mounted motor. The oil flows over a change control slide by means of which the tool slide movements are controlled, and connecting pipelines to two hydraulic cylinders move the tool slide up and down. The cutter guide bar is therefore hung between these two hydraulic cylinders, and this overcomes the strain on the slide guideways.

The change of direction of the tool slide is electro magnetic. The movement of the slide



Most of the keyseating machine is below floor level.

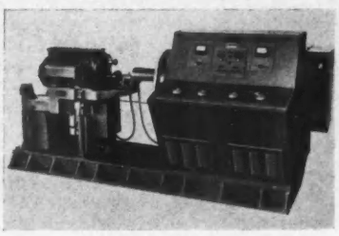
is transmitted by a chain and a Kardanshaft to the control cabinet, and from there to the stroke drum, and by simply adjusting the stops on the stroke drum, the length of stroke of the machine can be altered and set to correspond precisely to the length of the component.

The maximum cutting power of the machine is 8,000 kg (8 tons) and to safeguard the tool against overload, the cutting power can be steplessly limited by means of a contact manometer, so that the machine stops automatically when the set cutting power is exceeded.

Balancing Automobile Engines

The accompanying illustration shows a new compensator balancing machine developed by the Tinius Olsen Testing Machine Company being used to balance an automobile engine. Compensating weights of known value are used to determine the unbalance in this machine and since these compensating weights are known and are always the same, regardless of the part being balanced, calibration is eliminated.

The compensating system incorporates a pair of synchro motors placed in each of the two planes of correction. This makes it possible to introduce a force which is equal and opposite to the unbalance in the engine. When this is done, the cradle will remain quiet indicating that a state of balance has been reached. Each pair of synchro motors has two knobs. The left hand control turns the two synchro motors in unison, while the other control turns them in phase opposition. When they are turned in unison, the angular position of the unbalance is located, and when they are turned in opposition



Balancing an automobile engine.

the amount of compensating unbalance is determined.

With this system, the angular positions of the two compensator rotors are shown on the two "half moon" dials for each plane. The engine is corrected by adding on equal weight at the two indicated positions. This simplifies the balancing procedure since only one size of weight is required regardless of the amount of unbalance. These weights are so placed that their vector sum, like that of the compensators, is equal and opposite to the original unbalance in the engine. Weights are generally welded on the torque convertor or flywheel on one end of the engine and on the damper at the other end. The exact angular position of the resultant vector can be read on the angle dial, if this is desired.

These compensator balancing machines are available in either horizontal or vertical form. The sole agents for them in Great Britain are Edward G. Herbert Limited of Manchester.

Freeze Drying of Food Products

Extensions to Britain's first large scale industrial freeze drying plant have just been completed by Mitchell Engineering Limited, who designed and installed the original plant at a Hertfordshire factory in 1958. The whole plant has up till recently been used for the freeze drying of coffee extract on a commercial scale, but with the last few weeks experiments have been conducted on the freeze drying of milk. Results so far have been encouraging.

The process has been used for a number of

One of the freeze drying cabinets with the end removed.

years, particularly for the treatment and preservation of blood plasma, vaccines and biological materials. Basically, the process consists of the freezing of the substance being processed and the removal of its water content by sublimation under vacuum while the substance remains frozen solid. The water vapour is removed from the system by means of a refrigerated vapour condenser or a steam ejector.

The coffee is frozen *in situ* and the heat of sublimation is supplied by electrical elements situated above each tray and by circulating warm trichlorethylene under the tray.

Reconstitution of the product is effected by adding water. The product returns to its original appearance, shape and texture quickly.

Electromagnetism by Superconductivity

Recent research has revealed that superconductors, in which electrical current will flow without resistance, can now be used to produce powerful magnetic fields.

THE feasability of using superconducting solenoid magnets to produce extremely high magnetic fields has been demonstrated by research workers at the Bell Telephone Laboratories in the USA. The experiments which led to this demonstration made use of a new superconducting compound of niobium and tin (Nb_3Sn), manufactured and treated by special metallurgical techniques.

Although it has been realised for many years that it is theoretically possible to produce magnetic fields with superconducting solenoids, the materials that have been available in the past would only sustain fields of a few thousand gauss; at stronger magnetic fields the superconducting properties were found to disappear. With the new compound, steady-state magnetic fields of 88,000 gauss are said to be possible.

The most important point about a superconducting solenoid is that it does not require any electrical energy once the field has been established, whereas a solenoid of ordinary metal would use large amounts of energy.

Nb_3Sn becomes superconducting at 18° K, a higher transition temperature than any other superconductor known. This compound was first discovered at the Bell Laboratories in 1954 but, until recently, its critical field could not be measured because the material was too brittle to form into a solenoid

SUPERCONDUCTIVITY

The phenomenon of superconductivity was discovered by a Dutch physicist, Kamerlingh Onnes, in 1911. He found that the electrical resistance of some metals disappeared at very low temperatures and that below this transition temperature the metals could carry electrical currents without dissipating any energy.

Although possible applications for this phenomenon were immediately apparent, practical use could not be made of it for two reasons. First, the very low temperatures required ruled out most of the obvious applications, such as electrical power transmission. Secondly, it appeared that superconductivity was incompatible with high magnetic fields.

It was not until 1960 that a new attempt to produce a magnetic field with a superconductor resulted in a substantial field of 4,300 gauss being obtained. However, this work only further emphasised that, in order to extend the field of practical value for the "superconducting magnet," a new material was required—such as the compound that has now been developed by engineers at the Bell Laboratories.

100,000 GAUSS

In their early investigations, these research workers studied the properties of bars of the brittle Nb_3Sn, cut from an ingot of the compound which had been formed by melting niobium and tin together at about 2,400° C. They then found that the bars were superconductors, theoretically having zero electrical resistance in magnetic fields up to 88,000 gauss. Furthermore, in these high fields the bars could carry electrical currents of up to 3,000 amps per sq. cm at a temperature of 4·2° K (boiling point of liquid helium), without using energy.

They then set out to discover a way to circumvent the mechanical brittleness of Nb_3Sn. They started with a niobium tube of 0·25 in outside diameter and about 0·1 in inside diameter. This tube was packed with a mixture of powdered niobium and tin, in the ratio of 3 to 1. Since niobium and tin are both ductile metals before they are reacted, it was possible to seal the ends of this tube with N_b plugs and mechanically reduce the tube by swaging and drawing until a wire of about 0·015 in diameter was finally obtained.

This wire was found to be sufficiently ductile to be wound into a solenoid coil, but it did not possess the necessary superconducting qualities. In order to achieve superconductivity, the wire had then to be heated to about 1,000° C, so that the powders inside could react to form Nb_3Sn.

Tests have shown that, when the compound is formed by this second method (inside a niobium tube), it has better properties for high magnetic fields than an ingot of Nb_3Sn formed by melting at 2,400° C. In the wire form the compound is superconducting in fields of 88,000 gauss while carrying currents of over 150,000 amps per sq. cm. These current densities are fifty times as great as those that the ingot material can carry.

Laboratory facilities at Bell have restricted their measurements of magnetic density to fields of 88,000 gauss. However, experimental data have so far indicated that fields of 100,000 gauss, and possibly more, could be achieved with the new material.

It is believed that the superconducting solenoid will have important applications in the field of radio communications. Many electronic devices, such as travelling wave tubes and solid-state masers, require magnetic fields for their operation. Previously, device designers have often been limited to fields of less than 10,000 gauss because of the difficulty and expense of maintaining extra-strong fields. The new discovery, however, will permit the use of much higher magnetic fields, so extending the range of these devices to higher frequencies.

APPLICATIONS

Radio communication is only one of many areas in which the super-conducting magne promises to be of great value. Another application can be seen in experimental work on thermo-nuclear fusion, where large volumes of high-strength magnetic field are required to "contain" a high-temperature gas plasma. In recent concepts of such apparatus, one of the main problems is that the power required for the magnetic container uses a large fraction of the power produced by the nuclear fusion reaction and requires the construction of very large inductive reactors. The use of superconducting solenoids with Nb_3Sn, which in principle will not require any power, will permit a much greater flexibility in the design and study of fusion reactors. Although power will be required to maintain the low cryogenic temperatures which precipitate the superconducting state, it will in fact be a considerable amount less than a conventional solenoid would use to maintain its electromagnetic field.

Routine research studies of various physical phenomena in powerful magnetic fields will also be extended and improved by the advent of the superconducting magnet. In the past, the cost of producing strong fields in the laboratory has been a considerable restriction on investigational work. A large part of the cost of instruments used in nuclear physics, such as accelerators and bubble chambers, is expended in providing high-strength magnetic fields.

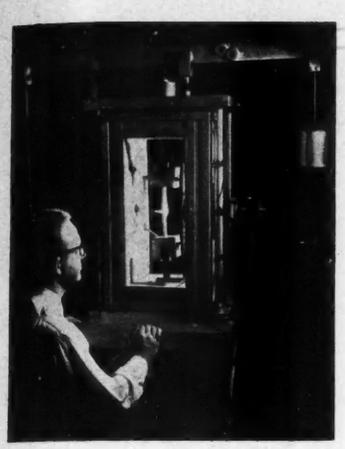
Although metallurgists at the Bell Laboratories have succeeded in producing the new superconducting compound in a wire form, it has not yet been possible to construct a full-scale working solenoid. This is because the mechanical forces produced by magnetic fields of the order of 100,000 gauss present formidable engineering problems. However, Bell engineers are confident that the solution to these problems is within their grasp, and that it will be only a matter of time (they estimate about a year) before a full size device is produced.

(Right) Experimental samples of the new superconducting compound are treated by radio-frequency heating.

(Left) A molybdenum-rhenium superconductive solenoid (shown in the hand of one of the Bell research workers) produces a field of 15,000 gauss. Below the new unit a conventional solenoid which produces 18,000 gauss.

Compressive Strengths of Columns

A buckling metal column has provided data to check the accuracy of a new analytical method for determining the compressive strength of columns at high temperature. With this new method of analysis, based on short-time stress-strain properties of materials, it is said to be possible to predict the stiffness of columns under conditions encountered by aircraft and missile structures.



An analysis has been developed to predict column stiffness at high temperature.

Previously it had been impossible to predict the properties of a column in which metal creep caused the shape to change continually.

Using this special equipment, designed and built at the Battelle Memorial Institute, Columbus, Ohio, USA, research workers have confirmed the validity of the analytical technique by applying compressive loads up to 2,000 lb to columns at temperatures of 325° F. The research programme is being sponsored by the US Air Force Aeronautical Research Laboratory.

Cutting Technique for Rolled Tubing

In modern steel tube mills, where the rolling trains are working at high speeds, it is often quite difficult to cut finished tubing to a standard length.

When hot, the tubes may be cut quite easily by various types of flying disc saws; but, when cold tubing has to be cut, it is considerably more difficult, especially with tubing welded electrically in continuous mills, where the finishing speeds can easily be as high as 3 ft per minute.

As such tubes are commonly shipped in lengths of about 20 ft, only about 6 sec are available for the cutting of each length. During this short period the cutting mechanism must get into step with the moving tube, grip it in jaws, cut through the tube and return to the starting position for the next cut. There can be no more than about 2 or 3 sec for the cutting operation itself. With thicker types of tubing this is almost bound to lead to a certain amount of damage to the profile of the tubing.

In recent articles published in the Soviet Union (Bogdanov, V. N., *Stal*, vol. 20, no. 7, '60, pp 634 to 635) a description is given of an approach to the problem which has been successfully tried out in the Leningrad and Dniepropetrovsk tube mills. It involves heating a narrow zone on the tube by electrical induction and then tearing the tubing apart. During the operation the moving tube is gripped in two pairs of jaws one of which is movable in relation to the other.

The magnitude of the force used to tear the tube is chosen so that the break takes place where and when the metal is in a plastic condition and has low tensile strength. In such a condition the thickness of the pipe at the torn end gradually diminishes.

The deformed length is approximately equal to the tube thickness, and the end is bevelled at a greater angle on the outside than on the inside. Such ends are said to be suitable for insertion into threading machines, so that they can be easily and properly threaded.

If the tearing force is too low, the break takes place at a higher temperature, when the metal is still brittle. This results in a rough break instead of a gradual transition to zero. If the tearing force is higher than the optimum, the length of deformation greatly exceeds the thickness of the tube wall.

The method is said to be applicable to tubing of almost any cross-section—circular, oval or rectangular.

Heating time is kept down by keeping the heated ring as narrow as possible, according to the Russian report, it should not be more than 6 to 10 mm.

Continuous Light from Optical Maser

The first continuously operating optical maser—a device capable of transmitting radio signals at optical frequencies—has been demonstrated by the Bell Telephone Laboratory in the USA.

It is only a few months (ENGNG., vol. 189, 11 Nov. '60, pp. 654 and 655) since the same laboratory announced their success with a ruby optical maser, which transmitted pulses of coherent light over a distance of twenty miles. The new maser works on a different principle and has produced a *continuous* beam of coherent light at the cost of only a few watts of power. Although the ruby maser was said to be theoretically capable of continuous output, it is estimated that it would have required power in the region of thousands of millions of watts.

The output beam of the new maser is said to be several hundred thousand times narrower in its frequency spectrum than any other coherent light source. This promises to make it one of the most efficient information carriers ever conceived, as well as an extremely useful instrument for spectroscopic research.

Unlike previous optical masers which made use of rubies and other crystals to obtain a stimulated light output, the new device is based

The first optical maser to produce a continuous, coherent beam of light was recently demonstrated in the USA.

on a gas discharge phenomenon. It uses a mixture of neon and helium gas which is energised by an electrical discharge.

Energy from the internal discharge excites the helium atoms to a very high upper metastable energy level, from which they normally would not radiate energy. The neon atoms in the mixture collide with the excited helium atoms, thus absorbing energy. The neon atoms can then be stimulated to radiate their energy on demand in a continuous stream. The beam is reflected back and forth through the length of the gas-filled tube by semi-reflecting end-plates, growing in intensity with each excursion. Some of the beam is transmitted through the plates to form the narrow output beam of coherent light.

Since the neon atoms can radiate energy from almost any one of four upper energy levels to one of ten intermediate levels, up to 30 discrete frequencies can be emitted, depending on the specific mode of operation. The range of possible wavelengths lies between 9,000 and 17,000 Å. Present laboratory models have operated at five different wavelengths between 11,000 and 12,000 Å. It is believed that, by using other gas mixtures, this range of frequencies can be extended quite considerably.

As with previous optical masers, the new device emits a beam with an extremely narrow cone angle. When emitted as a half inch diameter beam, its diameter would be only 12 in at a distance of one mile. If a suitable telescope were used as an output " aerial," the beam could travel for 100 miles before increasing its diameter to 12 in. It is thought that the new maser will be useful for obtaining precise measurements of distance over many miles, with accuracies unobtainable by present-day methods.

New Data on Tungsten Sheet

The demand for structural materials that will stand up to extreme temperatures has been greatly increased in recent years by the progress made in aircraft and missile propulsion systems. Because of their high melting point and elevated temperature strength, tungsten and its alloys have aroused the greatest amount of interest in this context.

Although tungsten has been in widespread use for some years now, it has been mostly confined to the electrical industries, where it has been used in a wire form. Consequently, little data is available on tungsten in sheet form. In an effort to find out more of the characteristics of sheet tungsten, the Battelle Memorial Institute, Columbus, Ohio, USA, has recently been investigating the material. The work was sponsored by the US Air Force Special Weapons Centre.

The lack of low temperature ductility is the primary problem in the use of tungsten. In their study, the Battelle metallurgists sought data on how the metal is affected by trace impurities and intentionally dispersed additions of inert materials. They wanted to learn how fabricability, recrystallisation behaviour, and ductile-brittle transition are affected, as a step toward increasing tungsten's low temperature ductility as a sheet material.

Briefly, the research provided the following information. A study with high purity tungsten made from single crystals revealed that 40 ppm (parts per million) of oxygen or 1 ppm of hydrogen have little effect on recrystallisation temperature, but 100 to 200 ppm of carbon tends to raise it from 1,200 to 1,300° C. Moreover, 10 ppm of trace metallic impurities appear to have a greater affect on recrystallisation temperature than does interstitial impurities. Tungsten single crystals were very ductile at room temperature. Introduction of grain boundaries by mechanical working and annealing, however, raised the bend-transition temperature to 320° C.

Addition of certain refractory oxides, nitrides or carbides raises the recrystallisation temperature of powder metallurgy tungsten from 1,600 to 1,800° C. The bend ductile-brittle transition temperature is lowered from 230 to 150° C for wrought tungsten and from 420 to 330° C for recrystallised tungsten when 2 volumes per cent of zirconia or thoria plus sodium oxide are added. Thus it was feasible to improve both elevated temperature properties and low temperature ductility by dispersion alloying.

"Paternoster" Lifts are Simple and Safe

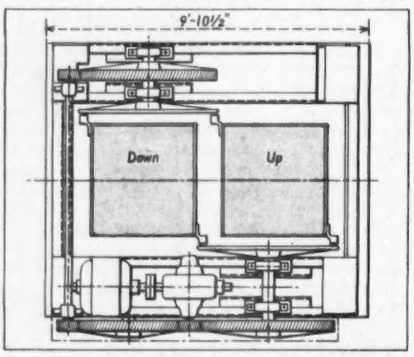
Efforts to increase the speed of ordinary lifts have led to more complex control gear. The Paternoster lift has none of this complexity and is always available when its services are required.

For many years, thousands of "Paternosters" or continuous lifts have been working on the Continent. They are not altogether unknown in this country as J. and E. Hall Limited of Dartford, Kent, installed two as long ago as 1870 for Ryland's premises in Manchester and one in Wood Street, London, which was working until the blitz in 1940.

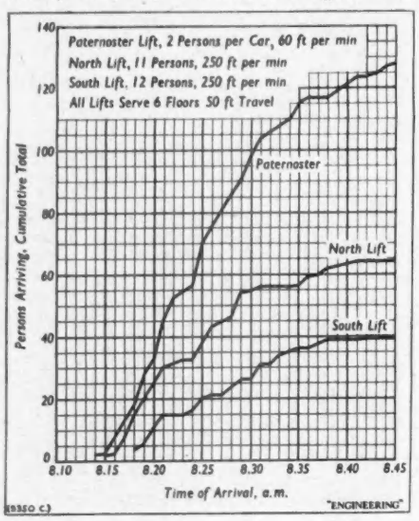
Soon after the Second World War, Halls decided to reintroduce Paternoster lifts and to date they have installed about 20 lifts of this type, including one in their own administration offices at Dartford, where six floors are served. Those installed at ICI's main offices at Billingham serve eight floors.

A lift of this type comprises two endless chains passing over large diameter sprocket wheels at the top and the bottom of the shaft. Cars, each large enough to comfortably hold two persons, are hung, suitably spaced, all along the chain so that they form two vertical trains of cars, one moving upwards and the other downwards with the travel of the chain. There are no doors on the cars or the landings. The vertical space between the cars is filled in by boards which are hinged to move if an obstruction is met.

Plan view of the driving gear showing how each car is attached to the two chains simultaneously.



Census taken of passenger traffic for Paternoster and orthodox north and south lifts installed recently in a large administration office block.



Before going into constructional details more fully, it is as well to mention the advantages this type of lift has to offer over others and what are its limitations.

First of all it must be pointed out that the Paternoster lift is really designed to provide interfloor communication and it is not their purpose to replace the normal express lift. In Hall's own offices, both types are installed to provide the two types of service.

The Paternoster provides a continuous service. The cars are passing all the time and should you wish to move up or down, there is a car to step into immediately. There are no doors to be opened and shut, the lifts are continuously running and for interfloor communication the orthodox lift cannot compete. As the accompanying graph shows, one Paternoster will handle as many passengers in the upward direction as at least two modern high-speed lifts, with the additional advantage of the downward cars being available at the same time. Normal operating speed is 60 ft per min, but this can be increased to 80 ft per min with little alteration when it is possible to handle up to 700 persons per hour. These are all advantages to the passenger.

OPERATION

As far as operation is concerned all that needs to be done is to turn the key switch in the morning and switch it off at night. A squirrel cage electric motor of approximately 8 hp provides the motive power to rotate the system in a clockwise direction. There are no complex controls as on an ordinary lift, no locks or door closing mechanisms, no contactors. Electricity charges and wear and tear are reduced because the motor is not continually starting and stopping.

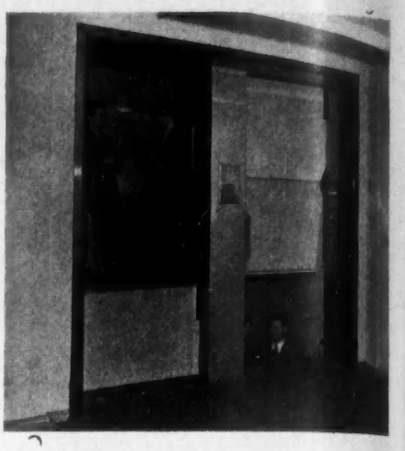
Perhaps the biggest difficulty the manufacturers are up against is persuading the potential buyer of their safety. Unless one has actually seen and travelled on a lift which does not stop it may not be easy to see how it can be anything but dangerous. After a little hesitation the first time, it is surprisingly easy and J. and E. Hall say that, as far as they are aware, no accidents to passengers have ever occurred. Statistics compiled by the leading insurance companies indicate that in practice, lifts of this type have a better record of freedom from accidents than conventional lifts or escalators.

After installation, most people have asked for an increase in speed from the initial 60 to the maximum 80 ft per min. Safety devices are built in. If a foot or shoulder protrudes and strikes the landing cill, no injury occurs as the cill is hinged and tips. If the same happens on the top landing a switch automatically stops the lift. There is a safety flap in the roof and floor of each car which will hinge back if obstructed from the landing. Should a passenger fail to step out at the top or bottom landing they are carried over or under in complete safety and can step out on the way back.

Turning to the constructional details, each of the cars—there are 14 for a normal six floor Paternoster—is attached to both of the chains at the back-left and front-right diagonal corner by extended pins which fit in the car anchorages. Lateral adjustment of the anchorages is possible. It can be seen from the illustration of the driving gear that the chains are also diagonally situated. They are driven through two trains of single helical spur gearing from a worm gear. The cars which are smooth and quiet in operation are fitted with guide shoes which are lined with leather. These shoes contact the guide rails which used to be made of wood with a metal backing but are now bright steel tubes. The guide rails are situated at the extreme outside edges and in the centre of the lift shaft.

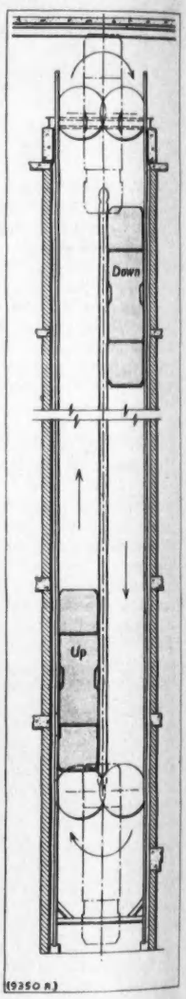
Having an inside height of 7 ft 3 in and measuring approximately 3 ft square, each car, complete with its steel sling, weighs approximately 6½ cwt. When a car reaches the bottom it is not only carried round by the chain but is guided by a bow of RS angle fitted to the car sling which meets with a corresponding guide bar fitted at the bottom of the shaft.

One car is provided with access panels through which the guide rails can be lubricated. Very little attention is required for the Paternosters and, because of their simple design and control gear, they are not prone to failure.

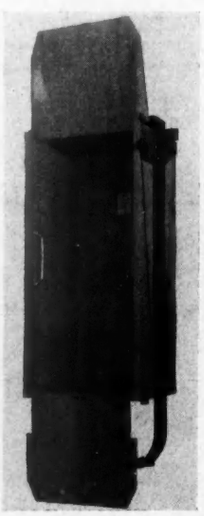


(Above) The Paternoster installed in J. and E. Hall's own offices has 12 cars and serves 6 floors.

(Right) Simplified front view of the lift arrangement. Cars are shown (chain dotted) in the changeover position at top and bottom and also one going up and one coming down. The sprocket wheels can be seen at the top and bottom of the shaft.



(Below) One of the cars, showing the hoods above and the apron below which fill in the space between the cars and are hinged to move if an obstruction is met. Guide shoes and bottom bow can be seen.

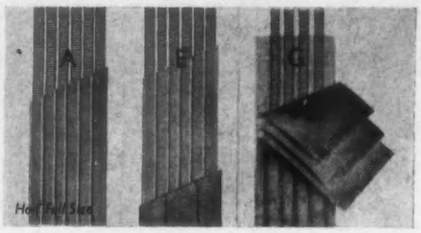


Better Surface Heating from Flat-Element Tapes

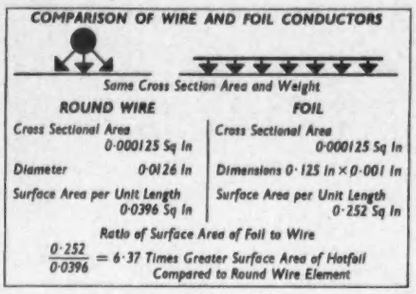
One of the most efficient ways to achieve surface heating is the direct conduction of heat from an element to the surface of the object. The better the contact, the less the temperature difference between the element and the surface that is being heated.

Heating tapes generally consist of conventional round wire elements which are woven into, or encased with, textile coverings. The limit of the temperature to which a pipe could be heated has been set by: (1) the temperature difference between the hottest part of the tape, namely the element, and the object being heated, and (2) the maximum safe operating temperature of the textile material which acts as an electrical insulator.

A flat element heating tape known as Hotfoil overcomes these difficulties. It is made up from flat metallic foil elements which have a large contact surface. A flat element must be very thin in order to have a high enough resistance and to heat up almost instantaneously; hence the use of metal foil which is plastic insulated so that any stresses in the tape caused by stretching or rough handling are not transmitted to the foil.



Hotfoil heating tapes give loadings of more than twice that obtainable with round-wire tapes.

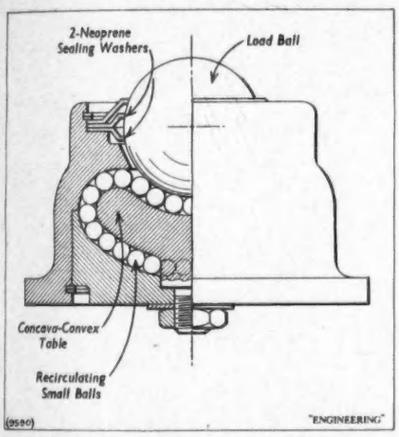

COMPARISON OF WIRE AND FOIL CONDUCTORS
Same Cross Section Area and Weight
ROUND WIRE
Cross Sectional Area 0·000125 Sq In
Diameter 0·0126 In
Surface Area per Unit Length 0·0396 Sq In
FOIL
Cross Sectional Area 0·000125 Sq In
Dimensions 0·125 In × 0·001 In
Surface Area per Unit Length 0·252 Sq In
Ratio of Surface Area of Foil to Wire
0·252 / 0·0396 = 6·37 Times Greater Surface Area of Hotfoil Compared to Round Wire Element

This sealed plastic construction also makes the tapes moisture proof.

Three versions of the tapes are available. Type A is for heating to 110° C. It is suitable for confined conditions and is ideal for laboratory apparatus, as it can be wound around pipes down to ¼ in dia.

Type E is also for heating to 110° C but unlike A has an additional woven glass protective covering. The tape which is 1⅛ in wide by $\frac{1}{32}$ in thick is suitable for industrial pipe installations such as maintaining the temperature of fuel-oil pipes. It can be fitted between pipes and preformed lagging sections. Type G is for heating up to 450° C and has triple woven glass insulation. It is still highly flexible. The makers are the MEI Co. Ltd., Upper Villiers Street, Wolverhampton. Mantles and pads for valves and drums are also available. Special tapes can be made to order.

Conveyor Ball-Units Give Quick Change of Direction



The Omni-track conveyor ball unit gives instantaneous change of direction, as distinct from a castor which trails. They can be placed at any angle.

Instantaneous change of direction is given with Omni-track conveyor ball-units. They can be placed at any angle through 360° as they will operate in any direction. Use can be made of them in a wide variety of conveyor systems, and for conveying tubes or bars they can be used in parallel lines with their axes subtending a satisfactory angle so that the tubes can be pushed along and rotated at the same time.

The makers claim that for accurately locating heavy articles such as electromagnets, Omni-tracks have proved better than a castor as there is no trail, and change of direction is instantaneous. They can also be used as cam followers and in this connection they can accommodate an inclination from the normal thrust angle of 23 to 25° due to the concave shape of the supporting bed of balls.

The main ball load is supported on a bed of small balls which recirculate about the entire surface of a hardened saucer-shaped steel table in such a way that as movement is imparted to the large ball the small balls roll over the table lip, under its surface and up to feed in over the opposite lip. The small balls are only under pressure when supporting the large contact ball.

First-quality precision steel balls are used throughout. For O-T's (as they are commonly called) up to and including 1 ton capacity, the housing is turned from mild steel bar. Over 1 ton they have housings of aluminium, manganese bronze or steel castings. Retaining caps are of mild steel and include two opposed Neoprene rubber sealing washers which retain the lubricant and prevent the ingress of foreign matter. Methods of fixing O-T's for the designs at present available include flanges, flanged sockets, pegs and screw pegs. The range varies from ½ in diameter for 75 lb load to 4 in diameter with a load of 20 tons.

When O-T's are run over mild steel the starting effort is approximately 3 per cent of the gross load, but when running over hardened and tempered steel it is as low as 0·3 per cent.

O-T's are designed to incorporate shock absorber springs and also to be provided with means of jacking so that once an article has been accurately positioned it can be clamped. The units are made by Autoset (Production) Limited, Stour Street, Birmingham, 18.

Immediate Depth from Echo-Sounder

Following a period of extensive trial on board their cargo vessel " Perim," P & O-Orient Lines have installed a new method of presenting echo-sounding information to the navigator, in several other vessels.

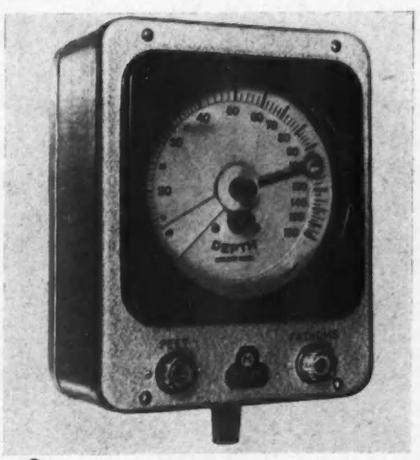
Known as " Metron," the system is said by the makers, the Marconi International Marine Communication Company Limited of Marconi House, Chelmsford, Essex, to use computer techniques. Considerable interest in the equipment has been shown by great line fishermen, in the Scandinavian countries as weil as Britain.

The depth of water beneath the ship in which the Metron is fitted is indicated by a pointer on a graduated circular scale, a glance at which shows the navigator the sounding at any given moment. Differing from several similar systems, the Metron reading shows is the actual depth at the time of the sounding and not the average over several soundings. Frequency of soundings is approximately one per second, so any sudden change of depth is shown within a second of its taking place.

The scale which is calibrated from 14 to 180 covers feet and fathoms; positive neon-light indication shows the scale in use. At the lower end of the scale, graduations are well spaced for accuracy in reading shallow soundings. For checking any appreciable changes in depth, a supplementary cursor can be set at the last significant reading. The cursor may also be preset for example on the 100 fathom mark when the vessel is approaching the coast, so that coincidence of cursor and pointer will immediately show when the 100 fathom line is crossed.

Four principal units form the complete Metron installation. The display meter itself (illustrated), the amplifier integrator, the transceiver, and a control switch, with, of course, the necessary projector assembly. Operation may be direct from 115V, 50 to 60 c/s, ac mains, or through a rotary convertor from dc mains of 110 or 220V.

The brain of the Metron is the amplifier integrator and is a form of simple computer which selects the signal received back from the sea bed at each sounding and applies the appropriate voltage to the display meter. All other echoes received, whether from intervening fish shoals, water aeration, or as re-echoes from the sea bed, are automatically rejected in the amplifier integrator, no matter how strong they may be, so that the navigator knows with certainty that the reading shown is that of the actual depth of water beneath his ship.



Display meter of the " Metron " echo sounder.

Washing Up

THE LATEST addition to the family of dishwashing machines is the Dishmaid by Electrolux, the first new appliance (as distinct from new model) introduced by the firm for nearly 30 years. It is also the cheapest dishwasher at present on the British market.

The Dishmaid is not a fully automatic machine; the water has to be turned on and off by hand and there is no automatic timing of the cycle. Neither does it incorporate a heater. For all that it is extremely simple to operate and economical of both electricity—the motor is rated at only 75 watts—and of hot water. For the actual washing cycle only 7 pints are required but to this must be added the water for the initial and final rinses, though not a lot is wanted in either case, and the outflow can be used to wash the saucepans in the sink for, like all other dishwashers at present available, the Dishmaid does not do the really hard work of the pots and pans.

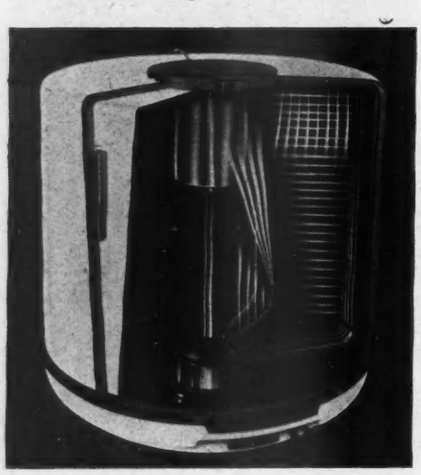
The Dishmaid can be stood on the draining board or mounted on a shelf. It requires a supply of hot water, taking about 4½ gallons to wash up after a three course lunch for four people.

The design is radically different from the existing machines. The plates are loaded on to a rotating basket in the machine, large ones on the top, small ones, cups and glasses below, with the cutlery in a basket, and the door closed. This arrangement eliminates the handling of racks or baskets full of crockery. A switch at the top starts the operation.

The basket rotates at 6 rpm and the crocks pass through three sets of water jets, at the top, sides and bottom. These jets operate in sequence with a 1 minute cycle. A rinsing cycle comes first when the hot water is turned on for approximately 1 minute with the outlet from the machine open. This removes the larger debris that has not been scraped off the plates before being put in. After a minute, or when the outflow is seen to be reasonably clean, the outlet is closed and the sump allowed to fill till water emerges from the overflow. The hot water is then turned off, there being about 7 pints left in the sump. With the addition of Electrolux washing powder the true washing cycle begins. This lasts for a recommended minimum of 4 minutes, but can be left running indefinitely since the same water is being used.

After the wash has been completed, the hot water is turned on again and the outlet opened to rinse away the soapy water, which can be conveniently collected to wash the saucepans. About 1½ minutes is suggested for this cycle. The water is then turned off and the outlet closed leaving about 2 pints in the machine and to this is injected a dose of Electrolux "rinse-aid," a wetting agent to ensure that the plates dry without spotting, especially in hard water areas. Opening the door allows the articles to dry in about 6 minutes. Thus the whole cycle takes some 7 minutes plus 6 minutes for drying and about 3 minutes for loading and unloading. Of course if the machine is used to store the crockery, a further saving can be made.

The three sets of water jets from the five tubes come into action in sequence as the basket revolves.



The main time saving that the machine effects is in the fact that it can be left running while another job is being done. The capacity is large enough to handle the dirties from a three course lunch for four people, including the coffee cups and glasses. More people can be catered for by running it during the meal, washing the plates for each course in turn. The quality of wash obtained is high, largely owing to the changing angles at which the jets (operating pressure 8 lb per sq. in) impinge on the dishes. A great feature of the Dishmaid is its silence.

The machine measures 21¼ in diameter and stands 21⅝ in high. Unloaded it weighs 40 lb. It can be placed on the draining board or mounted on a shelf at one side; a stand is also available as an extra. Connections are a flexible lead for the electrical supply (the machine is made for all standard voltages); a flexible hose to the tap, and another hose to waste. The minimum water temperature recommended is 120° F, the total consumption being quoted at 4½ gallons, though this will vary with the length of rinsing time given. The dish rack is made of plastic coated steel wire and the cutlery basket of nickel plated brass. The motor has self lubricated bearings and is fan cooled, while the pump is water lubricated. The body of the machine is enamelled aluminium and all exposed parts are of non-trusting materials. The motor is switched off automatically if the door is opened. It is expected to be generally available next May.

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